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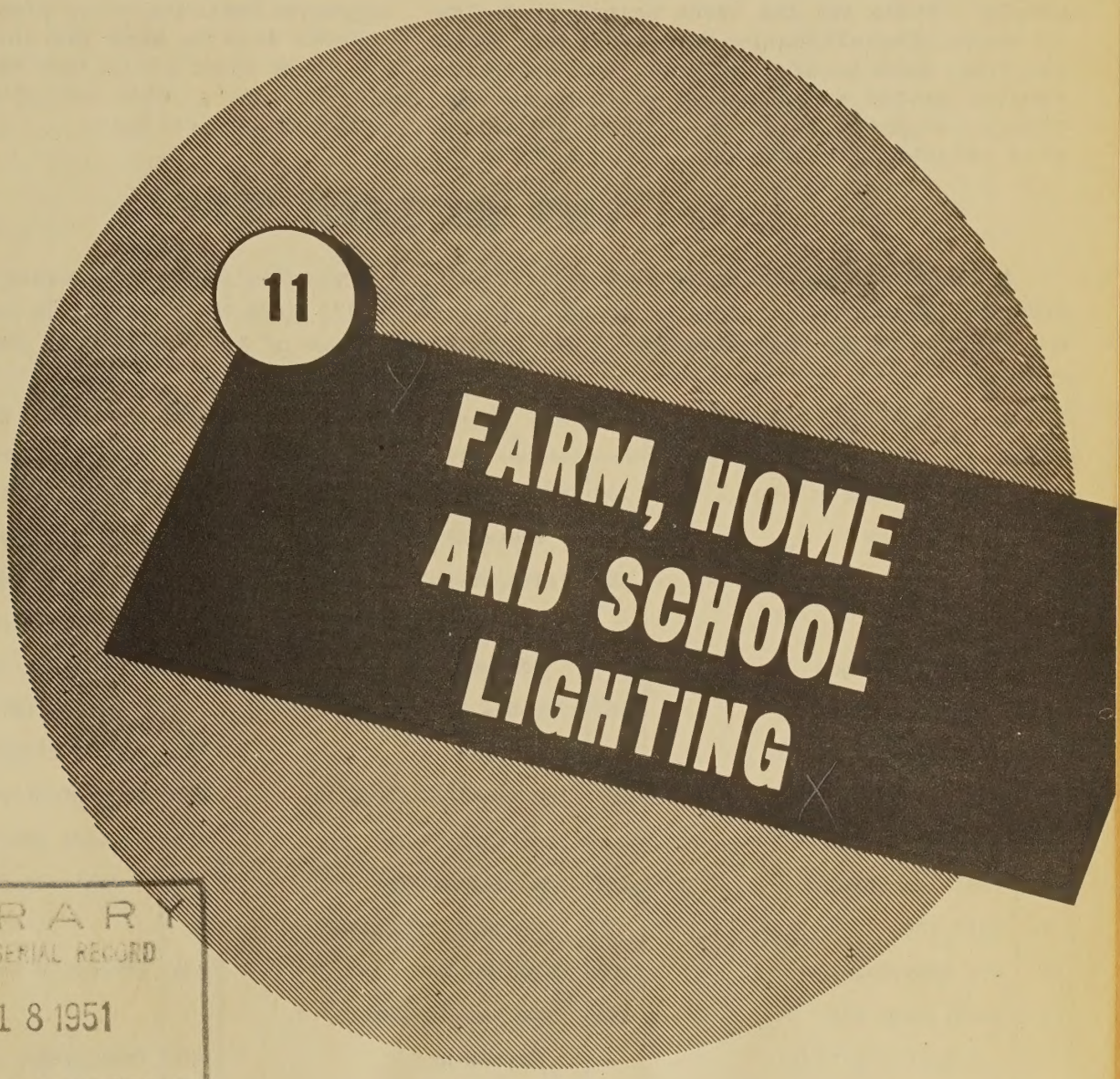
CO-OP ELECTRIFICATION ADVISER TRAINING OUTLINE



REA

RURAL ELECTRIFICATION ADMINISTRATION U.S. DEPT. OF AGRICULTURE

3-51

PURPOSES OF THIS OUTLINE

This is one of a series of outlines prepared by REA as an aid in planning and arranging training schools for co-op electrification advisers. Each outline deals with a power use subject or with some aspect of cooperative principles and practice or with a particular method or technique of getting information to people. These are the three principal fields in which electrification advisers need to be skilled. Each booklet contains both suggested subject matter and suggestions as to how the material might be presented, with an indication of a suitable time schedule. The booklet is thus useful as a guide to committees in charge of training schools, as an aid to the instructors, and as a subject matter manual that may be distributed to participants at the close of a training session for study and future reference. Subjects available or in preparation are listed below by title and number. *It is suggested that committees planning such training schools keep in mind the need of training in all three types of subject matter and, insofar as practicable, make use of the outlines in a balanced combination.*

LIST OF SUBJECTS

An ORIENTATION OUTLINE (unnumbered) covers all three fields of information. It is to provide the subject matter for an initial school that will give co-op officials basic background information and an understanding of the nature and scope of the educational job to be done.

NO.	POWER USE SUBJECT	NO.	CO-OP SUBJECT	NO.	METHOD OR TECHNIQUE
1	Farm and home Wiring	100	Value of Co-op Membership	200	Getting News to Members (Newsletters and State Paper Columns)
2	Farm Motors	101	Integrating Power Use and Co-op Education	201	Using the Radio
3	Water Systems and Plumbing	102	The REA Program and Co-ops	202	Co-op Reports and Non-periodical Publications
4	Electric Ranges	103	The Electric Co-op — What It Is	203	Making Effective Talks
5	Laundry Equipment	104	The Co-op Movement — Here and Abroad	204	Demonstration Techniques
6	Poultry Production	105	Co-op Bylaws	205	Methods and Results of Adult Education
7	Refrigerators, Home Freezers, Walk-Ins	106	Establishing Member Ownership	206	Effective Meetings
8	Small Appliances	107	Assuring Member Participation	207	Photography and Motion Pictures
9	Dairying	108	Co-op Tax Status	208	Working with Newspapers
10	Pig Brooding	109	Annual Meetings	209	Exhibits and displays
11	Farm, Home and School Lighting	110	Co-op's Place in the Community	210	Working with Rural Youth
12	Farm Shop	111	Cooperation Between Co-ops	211	Working with Community Organizations
13	Pump Irrigation				
14	Garden Watering				
15	Electric Hotbeds				
16	Elevating, cleaning and grading farm crops				
17	Drying grain, hay, peanuts, etc				
18	Heating, cooling, ventilating				
19	Cleaners, dish washers				
20	Kitchen planning				

CONTENTS

VALUE OF GOOD LIGHTING

Electric lighting on the farmstead contributes to human well-being and production of food and fiber. Both of these are important during a national emergency. In addition, electric lighting offers many other benefits.

Benefits of electric lighting: Some of the advantages of good electric lighting are that it:

Improves seeing; protects eyes; improves health
Increases production of food and fiber
Adds to length of working day
Helps in doing jobs quickly and efficiently
Enables workers to do jobs comfortably
Improves safety (helps prevent fires, thefts, accidents)
Improves attitude toward work
Improves children's scholarship, behavior, mental attitude
Improves beauty of interior; brightens color in house
Creates more cheerful environment
Extends useful space; creates effect of greater space
Lights areas quickly and conveniently
Helps promote cleanliness in home, on farm
Costs little for quantity of light provided
Requires little care or maintenance
Helps keep young people on farm, and at home

Human well-being: High morale, good health and safe surroundings help in keeping farm families on the job and producing to full capacity. Good lighting improves morale, contributes to health of eyes and body and decreases certain safety hazards. In addition, it plays a large part in making rural living more satisfying. This helps to keep people on the farm, producing the food and fiber needed, instead of seeking work elsewhere.

Production of food and fiber: Light, either alone or because of the heat accompanying it, plays a large part in producing food and fiber. It contributes directly to production by its use in brooding pigs, chicks, lambs and calves, in growing plants and raising the quality of farm produce. Indirectly, good lighting contributes to increased production by speeding work, saving time, lengthening the working day and saving energy. It makes farm labor go farther.

In saving time, lighting ranks second only to running water among farm and home electrical uses. Including the time it adds to the working day, it makes a greater contribution to getting work done than any other electrical usage.

The following production and time-saving figures come chiefly from studies made by various Agricultural Experiment Stations at State Universities in different sections of the United States. These figures show the high place lighting takes among other electrical uses in increasing production and saving time on the farm and in the home.

INCREASING PRODUCTION WITH ELECTRICITY:

Electrical use on farm	Increase in production
Poultry house lighting adds	4-5 eggs per hen per mo. in winter
Chick brooder saves	5-10 chicks per hundred
	8-12 turkeys per hundred
Pig brooder saves	1-2 pigs per litter
Lamb brooder benefits	5 percent of newborn flock
Water constantly available to milk cows	5-8 percent more milk, 6-11 percent more butterfat than when watered once or twice daily.
Water at 55° F. for steers	8 lbs. per mo. gain in winter.
Garden watering	10-52 percent more vegetables
Total saving of labor on farm	50 percent on most tasks done
	1 man can do work of 2 men

SAVING TIME ON FARM WITH ELECTRICITY:

	Daily	Yearly	8-hour days
Lighting adds to day	4 hr.	1460 hr.	182½
Lighting for chores	1-1½	547	68½
Water system saves (average farm)		270	33
Over hand pumping	2-4	730	91¼
Over gas pumping	¼-1	91	11½
Brooders--over coal	4	160	20
--over oil	1-2	40	5
Egg cleaners & graders		400	50
Small grinders & mixers		100	12½
Milking 16 cows	2	730	91¼
Separating 80 gals. milk	½	182	22½
Hay hoisting, 30 tons		60	7½
Silo filling		10	1¼
Elevators	2/3 time of older types		

SAVING TIME WITH ELECTRICAL HOUSEHOLD EQUIPMENT: Figures given below in number of 8-hour days saved per year are some averages of various studies:

Water system (22-63 days)	28	Dishwasher	14
Lighting for work	22	Ironer	11
Lighting adds to day (4 hours)	182½	Iron	10
Automatic over non-automatic laundry	15	Vacuum cleaner (6½-32; 13 days added by good use)	9
Washer	6-20		
Range	14	Refrigerator	8¼

Research on saving time with good lighting: "Chores can be done in less time with good lights than with poor ones," J. P. Schaenzer* says in Rural Electrification. "Food can be prepared quicker, dishes washed faster, and the sewing and mending done more rapidly when good lights are available. According to Wisconsin Circular No. 163, 'Turn on the Light,' a test was conducted to determine the time required to do the chores with electric lights as compared with the light of a lantern." As shown below the time was reduced 35 percent.

"Lantern Vs. Electric Lights for Chores"

Selected Farm Chores	Minutes to do the work	
	Lantern	Electric lights
Stabling cows	4	3
Cleaning mangers	9.50	7
Weighing and feeding grain	31.75	12
Feeding silage and hay	39.25	33
Total time	84.50	55

This means over 22 8-hour working days per year saved by lighting for these four chores.

"Forty-six questionnaires were received from Wisconsin farmers, by the Agricultural Engineering Department, College of Agriculture, in which 93 percent reported that good lights saved them an average of one hour per man each day in doing chores," Schaenzer continues.

"Adequate lighting alone saves 1½ hours a day by providing daylight for the chores. A recent survey of several hundred farms in 40 states showed 3½ hours were spent on chores on unelectrified farms compared to 2 hours on farms with electricity," according to Electro-Economy Supplement No. 2, published by USDA, REA, in 1941.

Cleaning electric lighting equipment requires 2 days less per year on an average farm than cleaning older forms of lighting equipment.

Conclusion: Good electric lighting contributes to sight conservation, health, safety, comfort, convenience, cheerfulness, beauty and advancement in the home and community life of rural areas. In some farming operations it also has an income-producing, quality-raising or money-saving value. The importance of good lighting can hardly be over-emphasized.

Good lighting depends on an adequate wiring system, proper selection of lamps and fixtures, good location of this lighting equipment, wise use of electric and natural lighting, dull finishes and light colors in interiors, regular cleaning and proper care and replacement of lamp bulbs or tubes.

*J. P. Schaenzer, Rural Electrification, Bruce Publishing Co., Milwaukee, Wis., 1948, pp 89-90.

FITTING LIGHTING INTO THE HOME

Importance of planning: Good lighting doesn't just happen by itself. Somone must spend some time, thought and study to get good lighting in a home and on the farm or in community buildings. In planning and buying, it is necessary to consider the cost of equipment, the amount of money you have to spend, your activities, the surroundings, the essentials of good lighting and the appearance of lighting equipment.

Good lighting is available at reasonable cost for home, farm and community lighting if buyers know how to tell the difference between good and poor equipment. Lighting equipment should be considered in its relation to human efficiency, health, safety, production and good seeing, for these things directly affect human well-being. There is far more to lighting than just buying a lamp or fixture and putting it in what seems to be a suitable place.

To copy the lighting of relatives or friends and neighbors is not a safe way to get good lighting. Many inefficient, antiquated fixtures are still on the market. Be careful to avoid these so that you will have a 1950 or 2000 lighting job instead of a 1920 one.

After lighting equipment is installed, be careful, but not close, in the use of it. Generous lighting for efficient and gracious living is within the means of most rural people. It is possible to make reasonably abundant use of lighting equipment since electricity is no longer expensive. But it takes good planning to get good lighting, no matter what the initial or operating cost of the equipment.

Good lighting of the home is a matter of concern to each member of the family. Consider the points in the following sections when planning.

Cost of equipment: Concern over cost of lighting equipment and its operation should not be a limiting factor in planning good lighting. Equipment which provides good lighting is available at various price levels. Often the operating cost is no higher than that of poor lighting equipment. If it is higher, the expenditure of the additional money should be considered necessary.

Amount of money to spend: Whether you are doing a new lighting job or bringing an old one up-to-date, you should make a decision on the total amount of money that you can afford to spend for lighting equipment. If you buy without plan, you soon find that there is no money left for other needs or other uses of electricity that you have been anticipating. There may not even be enough money left to complete the good lighting job you had planned.

Peet and Thye say in their book on Household Equipment*, "Adequate wiring usually costs 2 to 3 percent of the total cost of the house, and the fixtures another 2 to 3 percent." One commercial lighting information source says that when housing costs are very high a minimum for fixtures might be 1 percent of total house cost; 2 to 3 percent would provide some of the extras that give more of the benefits of electric lighting.

*Louise Jenison Peet and Lenore Sater Thye, Household Equipment, John Wiley and Sons, Inc., New York, N. Y., 1949, p 407.

If there is little money to spend on fixtures, use the inexpensive packaged fixtures. Also find low-cost certified (CIM) table lamps and pin-to-wall lamps. For a still cheaper lighting job, use adaptors for fixture lighting and homemade table and pin-to-wall lamps for close-seeing lighting.

Permanency of location: Whether you own your home or rent will influence you in deciding what type of lighting equipment to buy. Adaptors and portable lamps are an excellent choice if you rent. They furnish a means of having good lighting in houses which have been meagerly wired or poorly equipped. You can take this portable equipment along if you move to another farm.

The home owner can well afford to invest more money and put in permanent lighting equipment in his own home.

Family activities: After deciding how much money to spend, make a careful room-by-room analysis of your home. Jot down as you go through the house the different tasks family members do in each room and keep in mind where they are done. You will want to provide good lighting for these family activities.

Lighting for close seeing: In planning lighting, provide first for close-seeing tasks. If money for this equipment is budgeted first, it won't be so easy to omit it. Portable lamps are usually necessary to provide enough light for reading, sewing and writing. The number of lamps you buy for each room depends on how much you have to spend, the number in your family, the number of work areas and comfortable chairs, the size of the room and the activities carried on in the room.

General lighting: General illumination is provided economically by central ceiling fixtures. It is used for moving about in a room, listening to the radio, entertaining, playing games, talking and other general uses. General lighting also provides extra light for the close-seeing tasks being done under portable lamps, and more important, it ties all of the lighting in a room together and gives us well-balanced lighting free from disagreeable shadows and annoying, sharp contrasts.

Essentials of good lighting: In planning lighting and in buying your lighting equipment be sure to have the essentials of good lighting: first, enough light; second, comfortable lighting; and third, well-balanced lighting. Balance is really a factor in comfort of lighting, but it is so important that it deserves separate mention.

1. Enough light: To furnish enough light, use large enough bulbs and tubes and have them in enough places. In deciding what size bulb to buy for a ceiling fixture, keep in mind the rule of not less than 1 watt per square foot for storage, passage and living area ceiling fixtures and 2 watts per square foot for working areas.

   Most rooms need at least a 100-watt bulb or a larger total wattage in smaller bulbs in the ceiling fixture. A 100-watt bulb is the smallest bulb used in reading lamps. The 150-watt size is better in both places and necessary to protect eyes when studying. The 60's or possibly 40's may be used in bathroom brackets, at mirrors, over sinks, in multiple socket fixtures, in closets, on porches, in halls and on stairs (though 75's in good single-bulb fixtures might be safer in the last three places). Fluorescent tubes of about half these wattages will serve about the same purposes.

2. Comfortable lighting: In all of the main used rooms of your house, see that in addition to having enough light, you have comfortable lighting. The light should generally be softly diffused, well shaded and well balanced. One method of diffusing light is by passing it through a diffusing bowl or shield of opal or enamelled glass. Inside-frosted bulbs are used inside of these bowls. If shaded, a white indirect-light R-40 bulb is satisfactory without a bowl, except for prolonged studying. The bulb brightness is a little high for this. It reflects uncomfortably from shiny paper into the eyes. However, it provides good lighting for most sewing tasks.

   Light should be well shaded. It is easy to remember what makes a shade most efficient: White lining, not shiny inside, large, slightly slanting sides, light to medium colored translucent or opaque material.

   For most tasks, good light is softly diffused, well shaded, well balanced, and relatively free from glare and shadow. Light with a direct component, or undiffused light is satisfactory for certain tasks, such as ironing or hand sewing. It is also used at the workbench.

3. Well balanced lighting: There should be good balance in amount between general room lighting and special lighting for close seeing. This means having at least one-tenth as much general lighting around in a room as there is on the page you are reading under a portable lamp. It is better still if there is a third to a fifth as much light in the room, especially one-third as much in the area fairly close to the work. To read in a little island of bright light completely surrounded by darkness strains and tires the eyes.

4. Steady light of pleasing color: Light should be steady, free of flicker and pleasing in color. Colored bulbs are inefficient in delivering light. Red or yellow light is stimulating, later irritating and annoying. Bluish colors are cool, soothing and restful and show colors quite accurately, just as daylight does. But blue light also tends to be depressing.

   For the most part, you will want to use ordinary inside-frosted or white silica or ceramic bulbs, or tubes in some of the newer fluorescent colors. You may wish to use daylight bulbs or the slightly bluish white fluorescent colors for some particular work areas where color discrimination is important, such as at the washing, ironing or sewing centers.

Decoratively harmonious lighting equipment: In addition to having enough light and comfortable, well balanced lighting, you want your lighting equipment to add to the attractiveness of your home.

As you go from room to room, fixtures should harmonize with each other. This is especially true with rooms that are joined by a large double door. Have fixtures and lamps "go" with each other in design and height, or size, and in the shape, material and color of the shades. Also you want the lamps and fixtures within a room harmonious with each other. To have an attractive house, the lamps and fixtures should look as though they belonged with the house and furnishings in style, size, color and finish. They should be pleasing together both lighted and unlighted. But don't sacrifice your family's eyes to beauty in lighting equipment. You can find equipment which is both attractive and easy on eyes.

Buying lighting equipment: Having in mind points on money, family activities, general lighting, close seeing lighting, good lighting and decoration, you are ready to make a rough sketch of your lighting plan. Draw in the outlines of the rooms and the furniture and, using different symbols, locate the lighting equipment which you have and what you need to buy.

Learn how much different fixtures and lamps cost by shopping around at furniture stores, department stores, electric shops, mail order houses, hardware stores and distributors' display rooms in larger towns. Frequently wiremen and electrical dealers will lend catalogues which will give you more ideas and a wider choice.

Another session with your budget figures, the costs you have secured and your plan will narrow your field of selection.

Before buying any equipment you should see it lighted with the proper size light source in it and with other lighting equipment in the showroom not lighted. Then try to think how it will appear with other equipment--lighted or unlighted. It pays to learn all you can about lighting from educational and commercial sources, and, if possible, to get aid from a trained lighting specialist. Careful observation and thought will help to get a good lighting job.

Providing adequate wiring: The wiring system on which your lighting equipment is used should be put in by a good wireman. REA-financed cooperatives' inspectors check it to see that you receive your money's worth and that the wiring meets safety requirements. You must be responsible for having the wiring system adequate for your use. You will want to keep in mind when you are wiring:

1. Switches: Remember that ivory switches and outlets are more attractive against light colored walls than are brown ones. Plan to place switches so that the light can be turned on or off at the main-used doors. And, of course, have them put on the open side of the door, 42" up from the floor. A switch that controls a light at only one place is called a single pole switch. If a light is controlled at two different points, the switches are called three-way switches. Any switch added to conrol light at more than two places is a four-way switch. It is confusing to have more than three switches in any one place. Investigate low-voltage controls, sometimes called remote control wiring.

2. Convenience outlets: Convenience outlets are used for the plugging in of lamps and small appliances. When you wire your home, you should plan to have plenty of those outlets. Provide at least two outlets per room even in storerooms. Many more than this are necessary in most rooms, especially the living room and kitchen. In locating convenience outlets, it helps to remember that cords on appliances and lamps will reach about six feet from the outlet. Plug-in strips with outlets at regular intervals and fairly close together give great flexibility in use but add to cost. In the living room or any much-used room, also have a convenience outlet on each wall space over three feet long. Put outlets in the base board, just above it or preferably about 18" above the floor.

   Lighting outlets and convenience outlets for lamps are on general purpose circuits of #14 or #12 wire with 15-ampere protective devices.

The outlets for appliances in the kitchen, laundry and dining room need to be on heavier wiring than those in other rooms. Most of them plug in on appliance or 20-ampere circuits. Place these outlets higher, about 42 inches from the floor, to avoid stooping. Use at least #12 wire in these rooms. Some people like to use #10, which is a larger size. In addition, some equipment requires a special, individual appliance circuit--for example, the electric range.

3. Lighting outlets: Plan to have a ceiling fixture or built-in equipment for ceiling lighting in each room, or lamps on switch-controlled outlets. Consider using more than one fixture in rooms twice as long as wide, over 400 square feet, with alcoves or with very low ceilings. Provide light at mixing center, sink, range and on both sides of mirrors. Plan for light at sorting, washing and ironing centers and at work bench. Provide light on porch, at head and foot of stairways, for each 15 feet of hall and in closets over 9 square feet or 18" deep. While ceiling lights are usually centered in a room, they may be placed off center--over a working or dining area.

   It is cheaper to install outlets at the time of wiring than to add them later. However, if it is necessary to add some later, plan to have all of the extra ones added at one time.

Securing benefits of good lighting: Plan to take advantage of the benefits of good lighting.

1. Time and energy saving: Plan light enough for every job, with switches located to save steps, with fixtures and lamps that are easy to clean.

2. Safety: Plan lighting for all stairs and hallways--free of glare and shadows, controlled by three-way switches at main entrances. Provide good local light for places where potentially dangerous tools or machinery are to be used.

   Where lighting or other electric equipment is used around water or pipes, observe safety precautions. Put lighting outlets, switches and other electric equipment out of reach of the bathtub and the lavatory and other plumbing or wiring equipment. Avoid radiators also. Often the switch controlling the light in the bathroom is placed outside of the bathroom door.

   Plenty of outlets throughout the home will prevent the use of makeshift wiring. Extension cords strung around a room and under rugs are dangerous, unsightly and hard to clean around.

3. Profit: Light, usually because of the heat accompanying it, can be used on poultry, pigs, calves and lambs to increase farm profit. It proves profitable in connection with some plant production and improvement of quality of many products.

4. Health: Heat or infra-red radiation and ultra-violet rays are useful in connection with health of animals as well as humans. The germicidal lamp uses ultra-violet rays to kill bacteria and other injurious micro-organisms. It is used in some refrigerators and in public rooms.

Use and care of lighting equipment: After buying lighting equipment and installing it in your home, set up a regular schedule for cleaning the fixtures and lamps. Bulbs or tubes, glassware and light-reflecting surfaces must be clean for you to get the most light from the money which goes for electric lighting.

If lighting equipment isn't dusted for two or three months it may waste 15 to 35 percent of your light. If cleaned only twice a year, the loss may be as much as 50 percent of the light toward the end of the period. The bowl-shaped glassware or metal shields of fixtures and diffusing bowls inside portable lamps accumulate a lot of dust. Fixtures which collect dust easily need dusting every other week. Dust bowls in lamps every week.

At least six times a year or oftener wash lighting equipment. During certain periods of the year, it may be necessary to wash equipment once a month. A damp cloth followed by a dry one is sufficient for washing most lighting equipment, except in the kitchen. Disconnect lamp or remove parts before washing. Use soap for twice yearly cleaning and for grease.

Whiting or some fine cleaning abrasive will remove spots and polish dull surfaces. Some equipment is covered by a special lacquer. Acid and harsh abrasives may destroy this lacquer finish.

Remove bulbs or tubes, cool and wipe with a damp cloth to clean; never immerse in water. One large manufacturer says that you can immerse bulbs if you dry them well.

1. Extra supply of bulbs: Keep an extra supply of the sizes of bulbs and tubes commonly used in the home so that you can replace burned-out ones without taking one from some other place. Move blackened bulbs in places used for close seeing to less important spots in the attic, basement, closets or farm buildings.

2. Care of sockets and bulbs: Bulbs will last longer if they are not jarred severely. Don't attach appliances to light sockets. Sockets will usually carry 250 watts; at most special ones will carry 600 watts. Don't screw bulbs in and out of the sockets as a means of turning light on or off. Either kind of treatment wears out the socket by causing arcing or overheating.

3. Light-colored, dull finishes: Paint walls and ceilings a light color and keep them clean for greatest lighting efficiency. White ceilings are being used for their light reflecting efficiency in many new homes. Flat paints or dull-textured walls help prevent reflected glare. Finishes should be dull rather than shiny for best diffusion of light.

Cost of operation: On farms where the families are not overly careful but still not wasteful in using electricity for illumination, lighting uses between 30 and 50 kilowatt hours per month for the whole farm. A great deal more would be used if these farms all used good lighting.

The cost of electricity for lighting should not be considered as a new cost. Electricity replaces other methods of lighting. One average figure of $1.40 (20 kwh) per month for electricity for lighting in newly electrified homes has been given in comparison with $1.20 per month with kerosene. This shows little increase in the cost of lighting by electricity.

If the amount and quality of lighting given by electricity, is compared with that from an older form of lighting, anyone can see electricity gives a lot more for the money spent on lighting.

Summary: In planning lighting it is important to consider the following points:

Initial cost of equipment--make plan based on
  Reasonable cost estimate for fixtures
    (1-3% of total cost of house)
  Enough money for many portable lamps
  Amount of money family has for lighting equipment
Permanency of location--if renting, one should
  Buy adaptor fixtures to screw in like bulbs
  Put more money in good portable lamps
Family activities--provide family members with
  Special lighting for close seeing--lamps & brakcets
  General lighting for balance & easy seeing--fixtures
Good lighting essentials--amount, comfort, balance
Decorative harmony of equipment design & color
Benefits of good lighting:

Time-saving	Health	Production
Energy-saving	Safety	Decoration

Ease of cleaning, relamping, other upkeep
Maintenance and operating cost; wearing qualities

THE AMOUNT AND KIND OF LIGHTING NEEDED
(Terms, Principles, Measurement, Quantity and Quality)

Everyday experience teaches you that your eyes change light into sight. But what you really see is the results of the effect of the light energy not the light itself. This light energy is either projected to your eyes or reflected from some object or surface. In the end, light energy changes into heat and dissipates. Below is a little more technical information about light--some of which is still unproved theory.

Light--Its Control and Measurement

Definition of light: Light is radiant energy evaluated according to its capacity to produce visual sensation. It travels about 186,000 miles per second and at present is thought to be both corpuscular and wave-like. Photons or corpuscles of light, each a bundle of waves, probably move wave-fashion and in a straight line on a path called a ray. Wave lengths are measured in Angstroms (A. = 4-billionth of 1".) The wave-length range of the visible light spectrum is from about 7,600 A. for red light to 3,600 A. for violet. Mixture of all colors produces white light.

Light is part of the electromagnetic spectrum. This spectrum includes invisible radiations of longer wave length--electric, induction heating, radio and infra-red rays (beyond red); visible light--red, orange, yellow, green, blue and violet; and invisible radiations of shorter wave length--ultra-violet (below violet), X-ray, gamma and cosmic rays.

Light transmission theories: Some theories of light transmission are that light consists of motion of radiant energy in the form of:

Tiny particles or corpuscles moving in waves
Tiny particles or corpuscles in straight line
Electromagnetic waves through space
Electrons vibrating in source of light

The first theory--particles or corpuscles moving in waves--is the most widely accepted one. Objects are seen by the light reflected from them. Materials classify as follows according to their ability to transmit or let light pass through them: transparent--a lot of light; translucent--some light; opaque--no light. Transluence varies over a wide range.

Sources of light: In addition to the light from the sun, moon and stars, man commonly uses numerous other sources of light for seeing. More and more these sources are electric light sources. The more commonly known sources of light from electricity are: arc lamps, incandescent lamps, and gaseous discharge lamps, including fluorescent lamps.

The sources of light commonly used in the home and on the farm are incandescent and fluorescent lamps. The section on "Choice, Use and Care of Light Bulbs and Tubes" gives more detailed information on these sources of light.

1. Incandescent lamp: Light is produced by the heating effect of an electric current passing through a fine wire or filament of tungsten in a glass globe from which oxygen has been eliminated. The wire

becomes white hot when electricity flows through it for tungsten wire resists current passage. This produces light and heat. The filaments used are of these types:

Concentrated filament--in common bulbs
  One-filament--type commonly used, one light
  Two-filament--two or three-light lamp bulbs
Extended filament--in tubular bulbs (lumiline)

2. Fluorescent lamp: Electrodes at the ends of the tubular lamp give off electrons which collide with atoms of mercury vapor in the lamp producing invisible ultra-violet rays. These in turn are changed to visible rays by phosphors coating the inside of the tube.

Control of light: Electric light is controlled and directed chiefly by the following methods:

Wall switches or pull chains--to turn it off and on
Diffusing bowls, globes or louvers--to soften or shield it
Shades or reflecting materials--to redirect it. Shades also shield
Prisms, lenses, ribbed or configurated materials--to direct it

Some terms relating to light control are: diffusion (breaking and spreading), refraction (bending), reflection (redirecting) and polarization (vibrating strongly in certain directions).

Light measurement: Instruments, such as the light meter or brightness meter, can measure light. With a visibility meter it is possible to determine the comparative difficulty of many seeing tasks. Below is a summary of the units and instruments of light measurement:

Light--cause or source of lighting or illumination
  Measured in candlepower or lumen; for example,
    lamp bulbs are rated in lumens

Lighting--effect or result of light
  Quantity measured by a light meter in footcandles
  Brightness measured by a brightness meter in footlamberts or candles per square inch; or by a light meter in footcandles and converted--Ft-L equals ft-c x 1.25 (approximate)

For more information about this subject and methods of making these measurements, see the section on "Light Measurement."

Quantity: If you were to ask anyone, even a child, what one thing is most important to good lighting, you would probably get the answer, "Have plenty of it." The amount you need actually depends on what you are doing. There is probably no such thing as too much light for any job, provided the lighting is comfortable. However, the larger amounts of light which science shows desirable are difficult now for everyone to get for several reasons:

1. Electric power plants are not ready to produce the electricity for these large amounts of light for everyone.

2. Equipment to provide it is not widely available.

3. Electrical rates, while reasonable, are not low enough for everyone to afford the use of large amounts of light.

4. Heat produced by intense light sources at close range would be unbearable.

In the meantime, however, you can improve your own lighting to a point where it is safe lighting for your eyes. During the next half century, there will probably be many developments beyond those now known to make more light and better equipment available at even more reasonable cost than at present.

Light meter: Scientific research has fairly accurately determined the amount of light needed for different tasks. An instrument called a light meter will measure how much light there is at any point. It is small enough that it can be carried in a man's vest pocket or in a woman's purse. It can be used in any part of the home or in farm buildings to measure the amount of light at a particular place. The light meter can also be used to measure brightness of reflected or transmitted lighting.

This instrument has a mirror-like cell and a dial on the face of it. The dial is marked off in different ways:

1. In numbers from 0 to 75 or 100.

2. In letters from A to E combined with numbers.

The tiny mirror-like window in the light meter is a light-sensitive cell which catches the light from any direction and transfers it into electric energy. This electric energy causes a needle to move across the face of the dial. The needle moves like the needle on the speedometer of your car. It swings over to the higher numbers as more light comes to the light sensitive cell at the top of the meter.

Great care should be taken to always hold the light sensitive portion or the light meter in exactly the same position and at the same distance as the task for which you are measuring the light would be held. Before the development of light-measuring meters, measurement of light was all guesswork and just about as accurate as taking a person's temperature by feeling of his head. Now light measurement techniques include definition and size of task area or reading plane, location of task and light in relation to each other, number and location of readings to be taken and even control and measurement of surrounding area.

Measurement of light by the light meter has been a very important development in getting good lighting. Eyes adapt so easily to different amounts of light that is hard to tell whether there is enough light or not, unless the light is so dim you can't see, or your eyes hurt after trying to see with it.

Definition of footcandle: The light meter measures light by a unit called the footcandle. One footcandle of light is a very small amount of light as you will see. If you have a standard sized candle and put a light meter

one foot away from this candle, the meter will register approximately one footcandle of light. You can imagine what a small amount of light one candle gives to a whole room.

Even if 10 candles are burning instead of one, there is very little light by which to read. Is it any wonder that the scientists say from 0 to 10 footcandles are inadequate for most tasks.

England, France and the United States all use the footcandle as a unit of light measurement. This standard candle is among the standards maintained by the United States Bureau of Standards, Washington, D. C.

The technical definition of a footcandle according to the IES Handbook* is: "The footcandle is the unit of illumination when the foot is the unit of length. It is the illumination on a surface, one square foot in area, on which is uniformly distributed a flux of one lumen. It equals lumens per square foot."

A simpler definition to understand is: A footcandle is the amount of light at a point on a surface which is one foot from and perpendicular to the rays of a standard candle.

Outdoor measurement of light: At noon on a bright clear day in June light measurement may show as much as 10,000 footcandles of light in the open sunlight. Under the shade of a tree at the same time of the year, it may read around 1,000 footcandles. And up on the porch as much as 500. At the same time, inside a room near the window there will be between 200 and 300 footcandles of light. A few feet away from the window the amount drops rapidly from 50 to 30 footcandles or less. Here are some common amounts of light indoors and outdoors:

Indoor and Outdoor Lighting	In Footcandles
Bright sunlight, noon in June	8,000-10,000
In shade of tree; or cloudy day	500- 1,000
On porch--in shade	300- 500
Indoors by window	200- 300
Indoors by north window	50- 100
Moonlight (full)	0.02
Starlight	0.0002
Near good reading lamp	20- 50
Well-lighted interior at night	20- 50
Poorly lighted interior at night	3- 5
Three-light floor lamp (300 w)	15- 20 or 30
Same lamp with 3 40 w candles added	21- 26
CIM floor lamp, 10" bowl (300 w)	35
Same lamp with 32 w circular tube	45- 50

Of course, the above interior measurements can vary; all depend on placement and other factors. To measure larger amounts of light, greater than 75 or 100 footcandles, or the highest figure of the light meter, you use a multiplier. Place it over the light cell or silvery glass face of the light meter. This leaves just a small space through which the light can enter the light sensitive cell. This space is 1/10 as large as the area was before putting on the multiplier. Now, when you take a reading with the multiplier in place, you multiply that reading by 10 and that gives

*IES Handbook, Illuminating Engineering Society, 51 Madison Ave., New York 10, N. Y., 1947. Revision underway for 1951 release.

the approximate number of footcandles of light.

For measuring the brightness of sources and enclosing globes, use a "100" multiplier if you can obtain one. It is possible to make a special multiplier for this by using two small holes made by a #29 drill in a metal piece under the "10" multiplier. Divide the figure by 10 for brightness in candles per square inch.

Candles per square inch x 452 = footlamberts

See the section on "Light Measurement" for more details on this. When you make lighting measurements at night, you soon see how much more light there is in the daytime. Think how easy and pleasant it is to read under the shade of a tree, on the porch, inside near a window in the daylight. If it is comfortable light, a lot of light helps in doing eye tasks. However, reading in direct sunlight is not comfortable. There is too much brightness on the page.

Indoor measurement of light: Most of the readings made at night in homes are in the "danger zone" between 0 to 10 footcandles of light. This amount of light is inadequate for most tasks, though 5 to 10 footcandles of light is enough general lighting for moving about.

People who measure the light in a great many homes find that most families have between 3 and 10 footcandles of light at the places where they try to read. Even in homes usually considered well lighted, there is seldom over 15 footcandles of light at reading points. On the back of light meters there is usually a list of the different tasks and different amounts of light which are suitable for them. Instructions with a meter give helpful information on its use.

The Amount of Light Needed--Quantity

The amount of light needed varies for different tasks, different eyes and surrounding conditions.

Lighting requirements for different tasks: The Illuminating Engineering Society (IES) has set up lighting recommendations for various types of work and play. You will want to study these recommendations carefully.

Minimum footcandles recommended for specific visual tasks are given below:

Ft-c	Home area or activity to be lighted
5	General lighting in most rooms, halls & stairs
10	Kitchen general lighting; over card tables
20	Reading, casual periods (larger type). Writing
	Average sewing (periodic)
	Dressing table mirror (both sides of face)
40	Reading prolonged periods (smaller type)
	Average sewing (prolonged)
	Child's study table; studying at dining table
	Work counter, range, sink
	Ironer, ironing board, tubs
	Work bench
	Bathroom mirror (both sides of face)
100	Sewing on dark goods, fine needlework

To determine general lighting average a number of readings (at least five) well distributed throughout a room at 30" above the floor. Numerous other conditions related to quantity recommendations are given in IES' Home Lighting Recommended Practice (1947) and future changes in revised issues of it and of IES Handbook* (1947--being revised for 1951 release).

Since 1945, levels of illumination have sometimes been classed as follows:

Level	Ft-c	Ft-c Range	Used for the following Visual Tasks
A	100	70- 150	Very exacting and prolonged seeing tasks
B	50	30- 70	Severe and prolonged seeing tasks
C	20	15- 30	Moderately critical, prolonged seeing tasks
D	10	7- 15	Interrupted, casual non-discriminatory seeing
E	5	3- 7	Crude manual tasks, intermittently carried on
AA	200	150- 300	Extra fine inspection
AAA	500	300- 700	Accent lighting in show windows downtown
AAAA	1000	700-1500	Hospital operating table. Featured displays

Lighting needs of various types of eyes: The IES recommendations give the least amounts desirable for normal eyes. Lighting needs of various types of eyes vary considerably:

Young eyes are easily injured; too little light may tend to cause nearsightedness
Old eyes need more light to make up for decrease in pupil size, difficulty in focusing on near objects, other defects
Normal eyes should be treated with care
Defective eyes may need two to three times as much light as normal eyes for easy seeing
Light-colored eyes need more light than dark ones
Light-colored eyes are more sensitive to glare

Factors affecting quantity or amount of light: A number of factors affect the amount of light you get from your lighting equipment.

1. Size of bulb or tube: Very obviously the size (wattage rating) of the bulb or tube used in a portable lamp or fixture is a very important factor in determining the amount of light you get from that piece of equipment. Four 25 watt bulbs only give 65 percent as much light as a 100 watt bulb. It takes six 25 watt bulbs to furnish about the same amount of light as the 100 watt bulb.

100 watt light bulb ... 1600 lumens
25 watt light bulb ... 260 lumens

You can figure how much electricity would be used by the six 25 watt bulbs (6 x 25 = 150 watts). Also compare how much it would cost to buy six 25 watt bulbs with the cost of a 100 watt bulb. Larger incandescent bulbs are gas filled and are more efficient than the smaller bulbs which are vacuum bulbs. Remember also the higher the wattage the higher the efficiency in ordinary inside-frosted (A type) bulbs.

*Illuminating Engineering Society, 51 Madison Ave., New York 10, N. Y., 1947. Revision underway for 1951 release.

While this information is useful to know, you will find it applies chiefly to equipment for utility rooms. Ceiling fixtures in non-utility rooms or living areas are often best when they are of a multiple-socket type with 40 or 50 watt bulbs.

2. Color of bulb: Measurements of amounts of light from a 40-watt colored bulb and a 40-watt inside-frosted bulb will show how color in the bulb decreases the amount of light given off by it.

   There is another kind of bulb sometimes sold; it is a clear glass bulb. It looks like it would give a great deal more light than the inside-frosted bulb, but measurements show that there is less than 1 percent difference in the amount of light given by the two. In other words, if the clear glass bulb gives 100 percent of light, the inside-frosted one gives about 99 percent.

   Daylight (blue) incandescent light bulbs should be at least the next higher wattage rating to give somewhere nearly the same amount of light when replacing an inside-frosted bulb. The blue color absorbs light in transmitting it. Thus, use a 150-watt daylight light bulb to replace a 100-watt inside-frosted one.

3. Efficiency of transmitting materials: You can learn a lot about the efficiency of transmitting materials by making light measurements with portable lamps using different types of diffusing bowls. With the conditions the same, either with shade removed or in place in all cases and distances the same, take light measurements with diffusing bowls made of these materials: very thin, pebbly milky glass, thin smooth hand-blown glass, thick waffle glass, plastic, and clear configurated or clear ribbed glass. Among those now more widely available, bowls usually rate best first in order of highest readings as numbered. The amount of light from clear glass bowls is high, but quality may be poor.

4. Color and cleanliness of equipment: Color value and cleanliness of equipment affects how much light you get from it, as experiments will show. Try measuring the light under a good reading lamp. The inside of the shade is white. Now, take this shade off of the lamp and see what the light meter reading is with a translucent, colored shade or with a brown or colored shade lining. If a colored shade lining is not available, cut some brown wrapping paper to fit the inside of the shade and fasten that inside the shade with paper clips or scotch tape. Measure and compare the amount of light from each. It is surprising to find a loss of one-third to one-half of the light when you use the shade with color inside instead of the white lined one.

   Color in the lining of a shade, dust on the diffusing bowl, bulb or shade lining, dark colored ceilings or dark walls waste light. Dark colors absorb more light than do light colors.

5. Design of equipment: Using the same portable lamp, compare light measurement with just the diffusing bowl and bulb in place, then with the bare bulb alone. Next reassemble the lamp and with bowl and bulb in place take several readings at different distances with a flared shade on the lamp. Try the same readings with a shade with straight sides.

Which gives the wider spread of light? You will find, as you probably suspected, that a flaring shade gives a wider spread of light than a straight-sided one. Also note that a lamp with a good shade gives about twice as much light on the work area as when without a shade, using a diffusing bowl alone. The shade directs light on the work where you want it instead of letting it spread in all directions. You may be interested to compare the amount of light from a CIM crown bowl with that from a flared bowl of similar glassware and size. You will find the CIM bowl gives more light.

6. Distance: The distance away from the source of light affects the amount of light there. Lighting measurements very close under a lamp are not meaningful. Few people hold their work this close to the source of light. It is wise to take the footcandle reading at the place where you would normally be holding a book that you might be reading. Take measurements closer and farther away. At a distance of three feet there is about 1/9 as much light as when only one foot from the light source. Farther away from a lamp, the light is spread over a wider area so each part of the area gets only a fraction as much, inversely proportional to the square of the distance. Thus, at two feet away you get only about 1/4 as much light as at one foot; at three feet, the inverse of three squared, or 1/9; and five feet away, about 1/25 as much light. Strictly speaking, this exact ratio is true only when the source of light is a point. So you may find some variation from this in your measurements of lamps. With fluorescent tubes, you have a long source of light, not a point source.

7. Color and value of surroundings: The ceiling, walls, floors and furnishings in an area affect the amount of light in the room.

Percent of Light Reflected, or Reflection Factor* of Paint, Paper and Wood Finishes for Interiors:

Light		Medium		Dark		Wood Finishes		Other Surfaces	
Cream	75	Yellow	65	Gray	30	Maple	42	Silver	90-92
Gray	75	Buff	63	Red	13	Satinwood	34	White plaster	85-90
Yellow	75	Gray	55	Brown	10	Eng. oak	17	Glass mirror	82-88
Buff	70	Green	52	Blue	8	Walnut	16	White paint	75-85
Green	65	Blue	35	Green	7	Mahogany	12	Chromium	65
Blue	55							Black paint	3- 5
		White	85						

The reflection factor (RF) is very important in its effect on both the amount of light and comfort of the lighting. The lighting of a room is more satisfying when light is reflected in the following percentages:

IES recommendation*		Recommendations proposed	
Ceiling	65-80%	Ceiling	65-80%
Walls	35-55%	Walls	35-65%
Floors	10-20%	Floors	15-35%

A higher value is better in workrooms or utility rooms and a lower value is permissible for decorative purposes. The cleanliness of ceiling, walls and other surroundings is also important as dirt wastes light by decreasing the amount reflected.

*From "Recommended Practice of Home Lighting," Illuminating Engineering Society, 51 Madison Ave., New York 10, N. Y., June, 1947.

Checking for quantity of light in the home: Borrowing a light meter is one way of getting a measuring device to check the amount of light and the brightness at various places in your home. You may find you are like the minister's wife whose family did a lot of reading. She took a borrowed light meter home to check her lighting. When she brought it back she reported that there was only one place in the house where there was enough light for reading at night and that was standing under the ceiling fixture in the living room. She started to improve their lighting right away because reading was the favorite pastime of every member of her family.

To measure lighting in your home, you should measure it at night at the major seeing spots in your rooms. Measure the light at father's chair, at mother's favorite spot; measure the light on the music at the piano and on the work at the desk. Take the light meter to each place where different members of the family usually read, sew or work. Think of the tasks that are done at each place. Be careful to hold the light meter at exactly the same place as work, such as sewing or reading, is held. And as you go, think of the eyes that do the seeing there. Are they young eyes, old eyes, normal eyes or defective eyes? Old eyes and defective eyes require more light (often twice as much) in order to see as well as normal eyes. By changing to higher wattage bulb sizes, placing lamps closer to the work being done and using shades with white linings, you can increase the amount of light at each place measured. Even more important are the height of the lamp, the location of the light source and of the lower edge of the shade above the floor and interrelationships between furniture used and size and eye level of people using the area.

Sizes of bulbs recommended: Many people will not have the opportunity to use a light meter to measure their present lighting and to check lighting after they have improved it. Some general recommendations regarding the sizes of bulbs necessary to furnish the footcandles needed for different tasks and eye and room requirements may help get better lighting. These are given in more detail under the section on "Choice, Use and Care of Light Bulbs and Tubes" (see "Contents").

However, general recommendations of minimum incandescent lamp bulb wattages in shielded lighting equipment of better quality, single-bulb types for average homes in rural areas are:

150 to 300 watts	- Lamps for close seeing. Some utility fixtures.
150 or 100 watts	- Ceiling fixture in larger and smaller main-used rooms, respectively, for general lighting, to be supplemented for close work. Reading lamps (100 w lamps for casual seeing only).
75 watts	- Hall, stair and bath fixtures.
60 or 40 watts	- Utilitarian brackets to provide local lighting for work areas and mirrors; general lighting for small, less-used areas, like closets. Multiple-socket fixtures for living areas, passageways.

Minimum total fluorescent ceiling wattage (not including ballast) for shielded fixture or fixtures as suggested by IES pertains to specific equipment but can serve as a guide: 80--kitchen, dining room, living room; 60--large dinette; 40--bedroom, laundry (direct type); 30-32--small dinette, small bathroom and bedroom under 100 square feet. Use 15-40 watt brackets for mirrors and counter lighting. See (*) p 18.

The amount of light really needed depends on other lighting in the room. There are some dangers in giving summary figures of this type. They are too general and apt to be misleading. Room size, finish, type of equipment and other factors have an effect. But the above figures can serve as a guide.

Comfort of Lighting--Quality

Having enough light is important, but it is equally as necessary to good lighting to have that light comfortable to the eyes. Comfortable lighting, or lighting of good quality is softly diffused, well shaded or shielded, pleasing in brightness and color, well balanced and relatively free from glare and shadow. It is also steady and dependable.

Good lighting for most tasks (exceptions--at hand sewing and ironing centers, workbench) is soft, even lighting, but soft lighting is not good lighting if it is dim lighting. Almost every complaint of having too much light is an example of having lighting of poor quality.

Main factors effecting comfort: Comfort of seeing is the criterion for quality of lighting. Main factors involved include:

Diffusion of light
Minimum reflection of light source in glossy or specular surfaces (dull finishes, diffused sources)
Low ratio of task brightness to other brightness in the visual field
Sensitivity of individual eyes

Understanding the transmission and diffusion of light and its reflection helps in getting good lighting.

Classification of materials: Materials are classified according to their effect on light and whether the light source (or objects) are visible through them:

Transparent--transmit rays of light. Source visible through it.
Translucent--diffuse light. Source blurred or not visible.
Opaque --does not transmit. Source not visible through it.

Effect of materials in diffusing light: You should know the effect of different materials in diffusing light. They are given below:

Highly Diffusing	Partially Diffusing	Non-Diffusing Materials	
		Transparent --	Opaque--
Opal glass	Sand-blasted glass	Clear glass	Metal
Milky plastics	Etched glass	Clear plastics (slight diffusion)	Thick paper
Parchments	Silk, similar fabrics		Wood
Ceramic enamelled glass			

The very highly diffusing and partially diffusing materials are usually less difficult to use in getting good lighting than non-diffusing and opaque materials. Good diffusing materials help to provide lighting relatively free of shadows and glare.

Types of reflection: Minimum reflection of light source is important in getting good lighting. Below are common types of reflection and reflecting materials:

Diffuse	Spread	Regular (specular)
Parchment	Opal glass	Mirror (glass, plastic)
Flat paint	Cased glass	Polished aluminum
Most plastics	Porcelain enamel	Polished chromium
Blotters	Brushed brass	Polished brass
Mat finish	Satin chromium	Stainless steel
		Silver, monel

Diffuse reflection is the most desirable type of reflection. Spread reflection is next. Regular or specular reflection is undesirable, except to create interest. And then it is only desirable when seen for short periods of time unless very excellent lighting equipment is used near it.

Several satisfactory reflecting materials commonly used in lighting equipment are:

Mat white paint	Opal or enamelled glass
Porcelain enamel	Plastics
Etched aluminum	Treated fabrics

These materials are efficient in helping furnish both enough light and comfortable lighting. Of course, the lumens from the bulb or tube count too. Walls and ceilings should be mat, not gloss finish for the most comfortable effect. They provide more diffuse reflection while shiny finishes are glaring.

Measurements: Some factors entering into the comfort of lighting are measurable. These are brightness and indirectly brightness ratios. The instrument used is either a light meter or a brightness meter. The unit of measurement of brightness is the footlambert. For suggestions on how to measure brightness see section on "Light Measurement" Ft-c (from object) x 1.25 = Ft-L--approximate. Footlamberts as a measure of the brightness of an object depend on the reflection factor (RF) or transmission factor (TF) of the object.

Ft-c (from source) x RF (of object) = Ft-L Ft-c x TF = Ft-L

Definition of footlambert: The footlambert is defined by the IES Handbook as follows: "The footlambert is the unit of brightness equal to the average brightness of any surface emitting or reflecting one lumen per square foot."

Softly diffused, low brightness lighting: It is easier to show what is meant by lighting of good quality by showing the differences between comfort of poor lighting and better lighting. You can try the experiments below, comparing the brightness and apparent comfort of the lighting from different bulbs and from using different methods of transmitting, diffusing and reflecting light.

1. Unshielded, clear glass bulb gives poor lighting: Try looking at a clear glass bulb (150 w). The poor quality of this lighting is even more noticeable without other light in the room. This light produces an unpleasant sensation in the eyes. It increases fatigue and distracts attention from other things. With a glaring light of the same type in a room, eyes are attracted toward it and at the same time irritated by the raw harsh quality of the lighting. Instead of there being too much light, there is really just bad lighting, uncomfortable lighting.

2. Unshielded inside-frosted bulb is little better: Now try another bulb of the same size but frosted on the inside instead of a clear one, and compare the two. The light is a little more tolerable, but you are still annoyed by it and inclined to say again that there is too much light. You have improved the quality a little by using a bulb with a finish that breaks up the light rays, but the surface brightness is still too great for this light to be pleasing to your eyes. If necessary use unshielded inside-frosted bulbs like this only in the attic, closets or basement, but shield the bulb when it is used in main rooms or at any areas where you work.

   You will find the newer silica coated or ceramic white bulbs less spotty and more tolerable to look at than an ordinary inside-frosted bulb. The light from white bulbs is more evenly distributed, less spotty than from the clear glass or inside-frosted bulbs.

3. Unshaded white indirect-light bulb is only slightly better: Now try one of the larger white indirect-light R-40 bulbs. This bulb is all right in lamps with a shade to shield it, provided it isn't used too long for very close eye work like reading. But it is still too bright in direct line of view, though less bright, because larger, than the inside-frosted bulb.

4. Diffusing bowls or reflectors protect eyes: One of the first great steps forward in lighting came when one of the leading lighting engineers walked into a room having a ceiling fixture with bare bulbs. He held his hands up in front of his eyes and said, "There, that's what that needs, something between it and our eyes." Experiments with different materials between the eye and the source of light have resulted in different types of fixtures, making lighting more comfortable to the eyes. You can see the effect of shielding by putting a glass bowl or a metal shield around a bulb. If the glass bowl is a good one, it spreads and directs the rays of light and gives lighting of much better quality than a bare bulb--it is softly diffused, or broken up and more comfortable to the eyes. Notice that the bowl doesn't appear so bright as did the bulb. This is because the light spreads over a larger area. If you can find an old style etched glass fixture or clear glass diffusing bowl, put it around the bulb before you try the good bowl. The light will show through the etched or frosted glass in a bright annoying spot. If the bulb is a large one and the bowl small, the annoyance is very great. An etched design often produces this same annoying effect. Metal shielding has a different effect. Light cannot pass through it but reflects from its surfaces--going upward to the ceiling then down or directly downward into the room, or sidewise, all depending on where the metal shield is placed in relation to the light source. It is valuable to know which materials are best for diffusing light and which are excellent reflectors.

By trying different wattage bulbs in globes and bowls, you soon learn that a bowl is more comfortable to the eyes if used with the size bulb for which it was designed. The larger the fixture is the better for the brightness is lower than that of a smaller one.

5. Good shade improves comfort of lighting: Now, if you add a shade over the light inside of the diffusing bowl, it becomes still more pleasing to the eyes. This can be more easily seen if you try it in a dark room. Notice how much more pleasing the light is when you put the shade on than when the bowl alone is visible. Shading is very important with a light source at eye level.

   Some shades give better quality lighting than others do. Notice the effect of spottiness with a too thin shade, or glare from a shiny lining. This glare is easy to explain by thinking about light coming back or being reflected from shiny paper. Light from shiny paper is annoying, especially when using bare-bulb lighting equipment. A shade which has roughened paper on the inside gives better quality lighting than a shade with a shiny lining. And a shade which fits into its surroundings without too much contrast, both lighted and unlighted is more comfortable to the eyes. The light source should not show through its shade or shield in a spotty manner.

6. Luminaire design and lamping: For comfortable lighting the bowl, globe, metal reflector or shade around a light bulb must be large enough for the bulb needed for the task done there. Otherwise, the light from the bulb makes the luminaire too bright. And this is annoying, uncomfortable and distracting. Other factors to consider are:

   Shading of light source
   Spread of lighting from equipment
   Lighting of the equipment itself
   Equipment against its background
   Other lighting used in room.

   As an example of the "lighting of the equipment itself," the lighting of the lower part of an indirect type ceiling fixture is important.

Freedom from glare--definition: Good quality lighting is nearly free from glare. Glare is sometimes defined as light wrongly directed or poorly distributed. Some of the "eye-marks" of glare are:

   Unpleasant sensation in eyes
   Increase in eye fatigue
   Distraction of attention
   Contraction of pupil
   Reduction in ability to see

Types: There are three main kinds of glare, direct and indirect glare and glare by contrast.

1. Direct glare: Direct glare comes from a bulb or other light source that is unshaded or insufficiently shaded or shielded. It is more uncomfortable when in direct line with the eyes. It should be remembered that being seated, or looking down while working at a task, lowers the line of view.

2. Indirect glare: Indirect glare is reflected glare from light falling on a mirror, polished or shiny surface or glossy paper. Shiny varnish on a table top will produce indirect glare. Indirect glare from poor quality lighting is extremely annoying. It is more noticeable with common incandescent light bulbs than with white indirect-light bulbs or fluorescent tubes.

3. Glare by contrast: Spotty lighting produces still another form of glare and that is glare by contrast. One light turned on in a dark room provides an example of this. General lighting helps lessen glare by contrast.

Methods of remedying glare: Some methods to try in remedying glare are:

Move lighting equipment	Use dull finishes in area
Move seeing task	Change value of background
Move reflected glare source	Increase general lighting
Improve lighting equipment	Avoid sharp contrasts

Well balanced lighting: In addition to having enough light and comfortable lighting from the source, lighting needs to be well balanced or well distributed in the area around the task and in a room so that there is never too sharp a contrast between the high brightness local lighting and its background. Balance in lighting adds to eye comfort. Well balanced, well distributed lighting helps produce quality lighting. How much more pleasing the lighted lamp is when there is other light in the room. With ceiling fixture and other lights in a room off remember how a lighted lamp looked with and without its shade. Even with the shade on the lamp, a page held under this light is too brightly lighted. It contrasts too much with darker floors and dark corners of the room. The light itself contrasts too sharply with its background to be comfortable for long periods.

If you use a single lamp for close eye work, place the work and light so you are facing the wall. Or better still, use the lamp in a corner and face the corner. This gives light surroundings in which to work for the light reflects from the wall or walls. Place the lamp in relation to your work as you would in any area.

Providing general illumination in the room helps get rid of shadows and dark areas in corners or center of room. And the results are much more pleasing to the eyes if they are being used for close work. The size of the pupil of the eye does not have to change so much each time you look up from the brightly lighted page and out into the room. Some shadow and contrast may be desirable to lend interest in a room.

There are some recommendations on the desirable amounts of general illumination for different purposes. There should be at least 1/10* as much light in the room as on your work. Between work and surroundings a brightness ratio of 3 to 1 is desirable for reading or similar close work. You can get this general illumination from ceiling or wall fixtures or by having several portable lamps with open-top shades lighted in a room.

*Measure on a plane 30 inches above the floor. Average five readings--one at the center and four halfway between center and each of four corners of room.

For well balanced lighting it is desirable to avoid sharp contrast by using:

Large luminaires and large light sources
Equipment with up- and down-lighting effect
General lighting to balance local lighting
Colors and values with little contrast
Translucent equipment with light walls
Opaque equipment against dark backgrounds

Brightness ratios: The quality of lighting depends largely on maintaining proper balance between brightness of various objects or areas in field of view.

Suggested brightness relationships between zones of seeing in the home are as follows:

Zone 1 Area of Task--this area varies in extent with activity. Typical brightness of task ranges between 10 and 50 ft-L.

Zone 2 Area of Immediate Task Surroundings--this area immediately surrounds Zone 1 (task area). Zone 2 moves as eyes move in Zone 1.

No brightness should be greater than Zone 1 and none less than 1/10 as great. When task brightness is relatively high and when the task is one of long duration, the ratio should be as low as 3 to 1.

Zone 3 Area of Entire Task Surroundings--all areas within field of vision when eyes are concentrated on near work or when raised from the task. Zone 3 varies with movements of eyes, head and body. No substantial areas of brightness should be less than 1/10 or greater than 10 times Zone 1. Variations can be 100 to 1, though these areas should not be adjacent.

These recommendations below, come from those for schools and industrial areas. The first two especially are desirable for homes but seldom attained.

Object or Area in Field of View	Maximum Ratio
Between task and surrounding area	3 to 1
Between task and remote surfaces	10 to 1
Between lighting equipment and backgrounds	20 to 1
Between windows and adjacent surfaces	20 to 1
Anywhere within normal field of view	40 to 1
In schools--in normal field of view	30 to 1

Method of meeting brightness ratio recommendations: Illumination should be so distributed throughout a room that the surroundings have an illumination of about one-fifth to one-third that of the work space. Even a smaller difference is more comfortable. In homes it is generally recommended that the general lighting should be at least one-tenth that of the local lighting and preferably the relation should be one-fifth to one-third as many footcandles. If reflectance values are uniformly fairly high, recommended brightness ratios are easier to obtain.

Until it is installed, it is difficult to determine whether the brightness of equipment is pleasing or too great for comfort. Fixture brightness may be checked to some extent in a darkened store display room by seeing the equipment lighted with the proper size lamp bulbs or tubes and with other equipment turned off.

Maximum brightness: Some guides on maximum footlambert readings are summarized below:

Type of Equipment	Location	Maximum Ft-L	Candles Per Square Inch
Bowl-type fixture or shielded brackets	Eye level or above	400	0.9
Enclosing globe	Ceiling	1356	3
Portable lamp bowls	Under shade	2250 (2000-2500)	5 (4.5-5.5)
Study lamp shade	Eye level	75-85	
Dresser lamp shade	Eye level	250-500	
General purpose lamp shade	Eye level	100-250	
Indirectly lighted ceiling (non-residential)	Room with 50 ft-c general lighting	175	1/3-

Lighting of pleasing brightness: The brightness of objects and lighting equipment in line of view should be comfortable. This is largely a matter of balance in lighting between general lighting and lighting on local close-seeing tasks.

Causes of objectionable brightness: Objectionable brightness may result from:

Unshaded light sources--bare bulbs or tubes
Part of bulb or tube exposed below shield
Improper relation of light bulb to bowl size
  Diameter of bowl too small for bulb wattage
  Depth of bowl too shallow for bulb used
Glassware being too thin or poor quality
  Flashed opal glass preferable to etched or frosted
  Translucent glass or plastic varies in quality
Spots of excessive brightness on fixtures or lamps
  Etched designs Chromium trim Clear glass
  Transparent trim Large light bulbs Thin glass
Improper shades--too transparent, not deep enough
Fixture hung too close to ceiling making bright spot above
Ceiling too bright from using too large light bulbs
Fixture canopy too bright; shiny material

Light of pleasing color: Red and orange colored light is stimulating at first, later irritating. These colors are gay or fighting colors and used in the home, put people in an exhilarated, then in an irritated or fighting mood. Blue and green are more soothing and cooler in their effect, but slightly depressing and not flattering to skin coloring as they tend to gray it. Most of the lighting in homes comes from ordinary inside-frosted bulbs, the color of which is pleasing and familiar to the eye. Some of the new fluorescent tubes produce light resembling incandescent light. They also have the advantage of being a large light source and therefore not so bright, but shielding is still desirable.

Colored lights* also affect the appearance of the colors in a room as well as producing a psychological effect. This effect should be pleasing. The effect depends on colors already in the room as well as on the color of the light.

Steady light: The light source should be steady, not flickering. A flickering light source attracts attention from work to it and thus brings its brightness in direct line of view.

Summary: For whatever task is being done, there should be enough light and comfortable lighting--for easy seeing. For comfort lighting should be pleasing in brightness, balance and color. And it should be steady. For good lighting have:

Enough light for seeing tasks being done:
- Bulbs or tubes of correct wattage
- Equipment well located and in enough places
- Surroundings light-colored and clean
- Light close to work and free of shadows

Comfortable lighting:
- Softly diffused and well shaded or shielded
- Pleasing in brightness, balance and color
- Steady and dependable, not flickering
- Properly directed--little shadow or glare

Even, well balanced distribution of lighting
- General lighting should be at least 1/10 around to 1/3 close of special lighting on work

Reasonable initial and operating cost; easy upkeep

*E. W. Commery and Kaye A. Leighton, Fluorescent Lighting in the Home--Part I, Illuminating Engineering, December, 1950, pp 743-51.

LIGHT MEASUREMENT

Lighting can be measured with various instruments, called photometers. The most common of these is the light meter, which can measure both quantity and some factors relating to quality of lighting. Since quality is a sensation depending on many things, no one can measure it fully.

Light: The cause or source, light, is measured in candlepower and lumens. The light output of sources of light is rated in lumens and expressed in total lumens or lumens per watt (LPW). A light source emitting one candlepower uniformly in all directions produces 12.57 lumens. These measurements can be obtained from manufacturers' tables or roughly estimated for incandescent lamp bulbs by taking the footcandle reading in a black room with a light meter at a distance at least five times the greatest dimension of the source and using the first formula below. The trend in measuring this for long sources, like fluorescent tubes is to measure it for each 2 feet of length at a distance 10 feet from the tube. And average the measurements and use this in the last formula.

$$\text{Candlepower} = \text{Footcandles on surface} \times \text{distance in feet}^2 \text{ from source}$$

$$\text{Footcandles} = \frac{\text{Candlepower}}{\text{Distance in feet}^2}$$

$$\text{Lumens} = \text{Average candle power} \times 12.57$$

$$\text{Average candlepower} = \frac{\text{Lumens}}{12.57}$$

Lighting: The effect or result of light, which is lighting, is measured in footcandles by a light meter, and in footlamberts by either a light meter or a brightness meter. The footcandle is a measurement unit for intensity of light, and the footlambert, for brightness. Another unit for brightness measurement at high levels is candles per square inch. Formula showing some interrelationships are:

1 lumen over 1 square foot = 1 footcandle

1 candle per square inch = 452 footlamberts

$$\text{Footlamberts} = \text{Candles per square inch} \times 452$$

$$\frac{\text{Footlamberts}}{452} = \text{Candles per square inch}$$

A method for measuring brightness with a light meter when the reflection factor of opaque objects or the transmission factor of translucent materials is not known:

Footcandles x 1.25 = Footlamberts (approximate)

On taking the footcandle reading in the above formula, follow directions below:

Translucent objects: Put light meter cell against object.
Opaque objects: Hold light meter cell facing object 2"-6" away.*

Footlamberts = Footcandles x reflection factor (RF).

Footlamberts = Footcandles x transmission factor.

Reflection factor (approximate) = $\frac{\text{Footcandle reading* (cell facing object)}}{\text{Footcandle reading (cell facing light)}}$

Use of light meter: Below are a few points to observe in using a light meter:

1. Avoid getting thumb or shadow on cell face in holding light meter.

2. Place light meter with light cell on same plane as work.

3. Raise table lamp on block or books to same level as cell of light meter.

4. Use multiplier to measure amounts of light that swing needle over highest figure on dial. Multiply by 10.

5. Use a 100 multiplier to measure high level brightness. Or make a special multiplier to put under 10 X multiplier to measure higher brightness figures. Drill two holes with a #29 drill in a metal piece cut to fit over the light cell and under the 10 X multiplier. Space holes in the window of the 10 X multiplier equidistant from each other and tiny window edges. Place against enclosing globe and take reading. Divide by 10 to get approximate brightness in candles per square inch. Multiply by 452 for footlamberts.

*Get a constant reading with light meter cell at a distance of 2 inches to 6 inches away from object.

FARM LIGHTING EQUIPMENT

Below are listed reflectors commonly used in lighting farm yards and farm buildings.

Types of Reflectors

Trough reflectors: A long, narrow reflector with two or more fluorescent tubes placed above and parallel to the front edge of a work area provides good lighting for work surfaces.

RIM standard dome reflectors: Where ceilings are high enough, RIM skirted, standard dome reflectors are excellent and inexpensive for use in lighting the farm shop, garage, poultry house, dairy and beef barn, milk house, silo, horse barn, hog house, sheep shed, machinery shed and granary. They also find use in the laundry and cellar. The RIM reflector most widely used in farm buildings is 12" in diameter to fit the 100-watt inside-frosted bulb. The 14" RIM reflector with a 150-watt silvered-bowl bulb gives more comfortable lighting for close-seeing tasks.

Shallow dome reflectors: Shallow dome reflectors are used for yard lighting. Where a ceiling is very low as in many barns, the shallow dome reflector is preferable to the RIM standard or skirted dome. This shallow reflector directs light downward but does not shield the eyes from glare as efficiently as does the RIM standard dome.

Angle reflectors: Angle reflectors are used for lighting the haymow, farm name sign and road-side market. They are good for lighting the yard from the side or corner of a building and for any location that must have a fixture attached to a wall with the light concentrated in one direction. Angle reflectors come in sizes to fit 75 to 100 watt bulbs.

Bowl reflectors: Bowl reflectors are especially useful at places, such as the workbench, where intense light is needed for close work. There are several sizes to fit lamp bulbs from 75 to 200 watts.

Dust-tight and/or vapor-proof equipment: A dust-tight fixture has glassware which screws into a special fixture fitter and keeps out dust. One example uses a glass fruit jar to fit over a bulb. The fixture sometimes has a wire guard to further protect the lamp bulb. Addition of a rubber ring makes these screw-in globes "vapor-proof" as well as dust-tight. Dust-tight equipment is necessary for safety in granaries, elevators and haymows. Some are built with a reflector above them for better lighting.

Bulbs, Other Equipment

Rough-service bulbs: A 50 or 100 watt rough-service bulb, built to withstand jars and falls, is used in a wire guard on the end of an extension cord. Such a lamp is useful in repairing machinery or in places where it might be hit by an animal.

Reel or pulley: A light on an extension cord has many uses on a farm. Its convenience is greater in certain places when the cord is attached to a reel or pulley making it possible to raise or lower the light as work demands. This is especially useful in a silo.

Weatherproof bulbs: In addition to PAR (parabolic aluminized reflector) outdoor projector spot or flood bulbs, there are many sized bulbs of common shapes made of weather-proof glass for outdoor use. Use these with reflectors to increase lighting in a certain direction, or put ordinary bulbs below or inside of shields.

Floodlights and spotlights: Floodlights furnish lighting for the roadside vegetable stand, for working in the garden after dark and for flower garden lighting. These are available in 100, 200 watt and larger sizes. In outdoor locations use weather-proof stands equipped with weather-proof cord. Special equipment with door glasses or filters of red, blue, green or amber makes it possible to have many colored lighting effects. Spotlights are also useful in many places, where light needs to be directed at an object, such as a sign. For outdoor use choose PAR bulbs made of hard, weather-resistant glass.

Productive Uses

Sizes and types of bulbs and tubes for productive uses are covered in the separate section on "Choice, Use and Care of Light Bulbs and Tubes." Below are listed some of the farm applications of light to production:

Heat: Regular and pyrex glass infra-red heat bulbs help increase production when used in chick, pig, lamb and calf brooders. Infra-red bulbs keep humans warm when used over work areas, also thaw ice, warm motors, dry paint and penetrate flesh. Infra-red radiation soothes and lessens pain from injuries which are benefitted by application of heat. Avoid placement which will result in injury to bulbs or animals or danger of fire.

Sun lamps: Fluorescent, reflector-type and special more expensive sun lamps requiring transformer equipment are available for use on stock and poultry. Follow directions carefully to protect animals or workers from injury by improper or careless use.

Germicidal lamps: Germicidal or bactericidal lamps find use for sanitary purposes in farm work areas related to food production and in animal housing areas. Use approximately 30 watts per 100 sq. ft. in housing areas and about twice that much for food storage areas. Protect workers and animals' eyes from injury.

Insect repellents and traps: Yellow light from yellow fluorescent tubes or incandescent bulbs does not attract as many insects as white light would. Studies are underway to determine the value of fluorescent and incandescent lamps in insect traps.

Footcandle figures below may serve as guides for amounts of light for different farm tasks:

Ft-c*	Farm & Rural Industries--Area or Activity to be Lighted
1	Hay barn, breeding lots, barnyard and yard, hog houses, wood and lumber yard, gardens (decorative garden lighting 0.2 to 0.4 ft-c).
5	Poultry, laying and brooder houses; general lighting of animal or dairy barns; lambing shed. Recreational areas, such as for playing croquet or horseshoes.
10	Power-driven machinery and auto storage garage or shed; farm milk house; milk bottle storage; milk can washing; milk storage refrigerator; cleaning, grinding and elevating grain (granary); meat slaughtering; tobacco drying, stripping and general work.
20	Dairy milking shed; milk can washing, milk cooling, pasteurizing, separating; meat and poultry processing; rough sawing. Passage areas of rural markets.
30	Fluid milk testing and weighing; planing, rough sanding and sizing of wood.
40	General farm work bench.
50	Fine machine work; fine sanding and finishing of wood; auto and farm machinery repairing (farm shop); cleaning and sterilization of fluid milk bottles, fittings, pipes; bottle filling; inspections. General merchandising.
100	Grading and sorting tobacco. (However, color of light is more important than intensity.) Fine repair work and inspection.

There is little definite research yet in most areas of lighting for farm tasks. Figures used are largely adaptations of recommendations for similar commercial tasks.

*Footcandle recommendations adapted from IES Lighting Handbook.

THE CHOICE, PLACEMENT AND USE OF LIGHTING FIXTURES

Trends and Problems

Definition: Fixtures are installed or permanent lighting equipment as distinguished from portable lamps. These luminaires may be decorative for non-utility rooms or utilitarian for utility rooms. Properly chosen fixtures provide good lighting for either general or special purposes.

Recent trends: At the beginning of this century most lighting fixtures were truly "fixed" equipment. Gas fixtures were being changed over to electric ones. And people felt when they got this grand new form of lighting with electricity that their homes were lighted for all time to come. Recent findings about light and seeing have shown us that most of the fixtures of around the 1920's are as outmoded as the first automobile. Yet because they are fixtures, permanently installed, people hesitate to change them.

Ceiling fixtures are definitely "in" fashion, contrary to popular opinion in some areas. Leading authorities in the lighting field advise their use. But the equipment is very different from the old bare-bulb fixtures of earlier days.

The trend is toward larger fixtures and built-in or architectural equipment. Some of the newer living and dining room fixtures are 16 to 24 inches across. These may use 150 to 300 or more watts total in incandescent light bulbs or about 100 watts in nested circular fluorescent tubes*. There are also many fluorescent fixtures from two to four feet long and using up to four tubes of 20, 25, 30 or 40 watts. Residential fixtures in 30-watt size are not available.

Undoubtedly the luminous ceilings now being used in the commercial field will find their way into homes. The fluorescent tubes are above a ceiling of plastic louvers or preferably plastic panels. In some places inexpensive, replaceable, translucent paper provides the shielding needed and at lower cost.

Problems: Ceiling fixtures came into disfavor because the glare from unshaded bulbs in them was very annoying. Gradually as this was relieved by turning off the center light, the location rather than the type or comfort of the lighting was questioned. Starting in the 1930's urban builders put up many new homes without ceiling fixtures in the living room, dining room and bedroom. Lighting was provided by the new semi-indirect type floor and table lamps that came on the market at this time.

Experience with living in these homes soon shows that several lamps in a room must be turned on to get the same general lighting throughout the room as from a ceiling fixture. And this is costly in kwh consumption as the monthly electrical bill shows. When working with light from one or two lamps alone, darkness in the rest of the room is trying. The trend now is toward the use of both ceiling fixtures and lamps. In many new homes builders install simple, attractive, inexpensive fixtures that provide comfortable general lighting. The homemaker adds portable lamps, for

*Only the 12" size is available of three circular tube sizes planned: 16", 12", 8".

conventional fixtures alone do not provide plenty of comfortable lighting. Lighting from lamps improves the general lighting and provides necessary amounts of light for close-seeing tasks.

Styles of fixtures are available to fit into every room, but the number which furnish excellent lighting for specific tasks is limited, as you can see when you study the research tests on kitchen, laundry and bath-room lighting. See "Contents" for section on "Research on Lighting Home Activities."

Information about good lighting will help you find good fixtures or improve what you already have. In either case, you will want to consider the following points, and possibly some others, in buying or improving your fixtures:

Lighting	Construction	Style house, furnishings
Appearance	Safety	Permanency of location
Cost	Maintenance	Portable equipment available

Classification of Types

Types of lighting fixtures: Some classifications applied to fixtures which you should understand along with their characteristics are:

Utilitarian	Wall	Pendant	General purpose	Pan, bowl or globe
Decorative	Ceiling	Close fitting	Special purpose	Cluster or shower

Classification by appearance: You may speak of fixtures as utilitarian (for utility rooms or workrooms) or decorative (for non-utility rooms or living areas). Decorative fixtures may be wholly decorative, as sconce brackets, or a combination of decorative and utilitarian. You will find this latter type more useful to you and a better lighting investment in both initial and operating cost.

Classification according to location: Lighting equipment classifies as pendant, close-fitting or built-in according to its relation with the surface surrounding it. Wall brackets and ceiling fixtures are common terms showing location.

1. Pendant or close-fitting and built-in equipment: In high ceiling rooms, ceiling fixtures are often of the pendant or hanging type, suspended from the ceiling by a rigid rod or stem, or by a flexible chain. In low ceilinged rooms fixtures must be close fitting. In general, the present trend among newer fixtures is toward this type in a large size.

   Lighting which is built into the homes and termed architectural lighting, as distinguished from easily removed fixtures or luminaires is also popular but expensive. Glass panels or louvers are built in flush with the ceiling, the lighting equipment being recessed into the ceiling of a room. This type is called recessed lighting. Sometimes an area is furred in or built down from the ceiling to enclose lighting equipment. This is soffit lighting. It is easy to install in some places, such as between cabinets above a sink in the kitchen. Light may be concealed in a ledge or trough or behind a piece of wood.

You can build this or attach it to the ceiling at the place where the ceiling meets the walls, or place it on or in the side wall itself. It is called cornice lighting if it is a 6 or 8" horizontal piece of wood or plaster attached to the ceiling to conceal a source to light the walls. When it is on the upper sidewall and lights the ceiling, it is cove lighting. Fluorescent or occasionally lumiline incandescent tubes and even incandescent bulbs are being used in coves and behind cornices. There are also window valance, bookcase, niche and other forms of architectural lighting, such as fixtures permanently installed on the top of built-in furniture.

2. Wall brackets and ceiling fixtures: Fixtures used on walls are called brackets, wall brackets or side or wall lights. This distinguishes them from those on ceilings, which are called ceiling fixtures. Brackets are further spoken of occasionally as close-fitting, swing-arm or pendant brackets, though the latter two types are rare anymore. Sometimes you will hear of over-mirror, side-mirror or under-cabinet brackets. Also central or center-ceiling fixtures or over-work-area fixtures apply to these locations. Recessed and applied architectural lighting discussed above falls into a little different classification as already given.

Classification by method of light distribution: According to the way they are made and the type of material that is used in them, fixtures may give direct, semi-direct, general diffuse, semi-indirect or indirect lighting. Direct and semi-direct fixtures send most of the light downward, while semi-indirect and indirect fixtures send most of the light upward. General diffuse fixtures are spread lighting or distributing fixtures which send light in all directions about equally. Lighting from semi-direct, general diffuse and semi-indirect fixtures is more comfortable than direct lighting.

1. Direct: A direct lighting fixture sends all or nearly all of its light downward. This type of fixture is usually inexpensive to buy and operate but not so commonly used now in good lighting practice. Incandescent bulbs in metal reflectors give direct lighting. Direct light, especially from incandescent bulbs, is glaring and undesirable except for a few special tasks requiring some of it, for example, hand sewing. It produces harsh shadows. Direct lighting is satisfactory in less used parts of attics, basements, closets and parts of farm buildings. It is also used with high or dark ceilings that waste light. When it is well handled it is suitable over an ironer, a work bench and at a few other work areas, such as sewing centers. In these latter uses, it is desirable to have other lighting also used in the room to help improve the quality of the work-center lighting. The long, wide spread of semi-direct lighting from tubes in reflectors give good lighting in these places, and a silvered-bowl incandescent bulb in a reflector gives satisfactory lighting and at a lower fixture cost.

The newer type of direct lighting fixture makes use of louvers or metal strips about 1½ inches deep set into the ceiling below the light source or on the bottom of a fixture. These are of dull gray, mat white or of a dull-finished aluminum; their purpose is to shield the light source and improve the quality of the direct lighting. Also

silvered-bowl bulbs are used in round white-lined metal reflectors to give more comfortable lighting from these direct fixtures. Improved quality direct lighting is quite useful in a number of places where work is casual, for short periods or on dull-surfaced objects.

2. Semi-direct: A semi-direct fixture sends most of its light downward but a little goes upward to light the ceiling. Semi-direct lighting equipment helps to give lighting of better quality than direct lighting. An example of semi-direct lighting is the close-fitting glass enclosing type of fixture used in low-ceilinged rooms. These are common in kitchens, laundries, halls and porches and occasionally found in living rooms, dining rooms and bedrooms. This is an economical method of lighting. The fixtures are fairly low in cost and the size light bulbs used make for low operating cost. The light is much better in quality than that found in bare-bulb direct lighting.

   The close fitting semi-direct fixture is good for use with ceilings too low for a general diffuse or semi-indirect type. It is better if the fixture has a slit or is designed to deliver enough light on the ceiling so that the ceiling is light, cheerful and comfortable as a background for the fixture. A slit also provides a means for heat to escape. Some louvered fluorescent fixtures light the ceiling well and provide excellent semi-direct lighting.

3. General diffuse: The general diffuse (direct-indirect) fixture spreads its light fairly evenly in all directions. It furnishes about equal amounts of uplighting and downlighting. A good fixture of this type--with medium dense translucent glassware and a bowl large enough for the bulb--provides good quality lighting. A small or thin bowl with a large bulb makes the glassware too bright for comfort.

4. Semi-indirect: A semi-indirect fixture sends more of its light to the ceiling but a lot of it goes downward through the bowl. While sometimes it is a fairly close-fitting globe, the fixture is usually suspended from the ceiling. It may be either a single open bowl or a multiple-bowl type. Multiple-bowl cluster or shower fixtures have three or five small bowls, chimney globes or shades.

   If properly designed, semi-indirect lighting fixtures give very comfortable lighting. There is also a nice balance between operating cost and efficiency which makes this type of lighting highly desirable. When chosen for suitability to their location, these fixtures may be used anywhere in the home. They are especially popular in the living room, dining room and bedrooms. Multiple-bowl cluster, or shower, fixtures are chiefly decorative fixtures, therefore, unsuitable for work areas in the house. They also have more parts to clean than a single-bowl fixture.

   The types of semi-indirect fixtures available include:

   Single open bowl or basin--glass, or glass and metal combinations.
   Enclosed globe--globe with dense glass bottom, for workrooms.
   Multiple-bowl cluster or shower--several small shades, open bowls, chimney globes or lanterns, for living areas.

While multiple-bowl cluster fixtures are chiefly decorative, five socket ones can be useful also if glassware is dense enough but still quite translucent and large enough to use higher wattage (60 w) bulbs. You can use this type over a dining table.

5. Indirect: An indirect fixture sends nearly all of its light to the ceiling from which the light comes back into the room. The ceiling becomes a source of light like the sky. The best of this type of equipment gives enough light of high quality for general lighting when used with a smooth, dull-finished, light-colored background. This is true, provided, of course, that tbere are enough bulbs of high enough wattage in the fixture. When properly installed, the lighting is soft and well-diffused, therefore comfortable, but often very flat and uninteresting.

Indirect lighting is suitable in any room, especially if you add highlights in some other way. To get best results, ceilings must be white or very light and in fairly good condition. When lighted brightly, patched cracks, uneven plaster, patched papering and other defects show plainly and are distracting.

Indirect fixtures are basin-like fixtures of metal, open-bowl fixtures of dense glass or a combination of the metal and glass. These fixtures use larger bulbs to give the same amount of light as other types, since there is some additional loss of light. One of the reasons for this is because the light must go farther. It goes first to the ceiling and then down into the room. Absorption alos causes some loss during additional reflection. Despite this, where indirect lighting is used, the operating cost is not prohibitive. Most indirect-fixtures are modern in appearance, but some fit into rooms of older styles and different periods. However, they do not usually copy old forms of lighting equipment exactly. In addition to being available in attractive styles, the lighting from them is of the highest quality. Below are the types available and their advantages and disadvantages:

Luminous bowl--open bowl of dense glass--pleasing with light or white ceilings and lighter backgrounds.

Solid metal basin--satisfactory in rooms with very dark walls, but likely to be too dark against ceiling unless plenty of light is provided by lamps below.

Two section, or slit metal basin--slit designed to let light through to light fixture. Prevents fixture appearing dark against light ceiling or wall by lighting part of the fixture. This type is more desirable than solid metal or other opaque materials.

Luminous section--metal basin with glass area--glass area helps light fixture, also area directly below. Good in light colored rooms and in dining rooms.

Below is a summary of lighting distribution by ceiling fixtures, wall brackets and portable lamps:

Type Fixture	Light Up-%*	Light Down-%	Lighting Result on Area (Advantage, Disadvantage)	Common Example or Typical Place of Use
Indirect	90-100	0-10	Lighting quality high, quantity low for watts.	Torcheres; metal or dense glass fixtures.
Semi-indirect	60-90	10-40	Medium operation cost, good general lighting, little glare or shadow.	Glass, or metal & glass bowls; some globes; for living rooms, bedrooms.
General diffuse (Direct-indirect)	40-60	40-60	Efficient; comfortable if glass diffuses evenly, not spottily, & bowl is large enough to prevent annoying brightness.	Common kitchen globe for use in kitchen, workrooms, laundries, farm buildings; some types for other rooms.
Semi-direct	10-40	60-90	High light output below; some shadows, contrast. (See general diffuse)	Close-fitting glass enclosing globes for use throughout house.
Direct	0-10	90-100	Delivers most light per w; harsh shadows and glare, unless shielded.	Metal reflectors in yard, farm buildings, workrooms, basement.

Certain bracket and ceiling fixture and lamp terms are interrelated as given below, reading across:

Appearance of design	Distribution of lighting	Lighting effect
Open-top.....	Indirect or semi-indirect....	Uplighting
Open-bottom.....	Semi-direct or direct.....	Downlighting
Enclosed.....	General diffuse, semi-direct.	Distributing

Purpose of lighting fixtures: It is well to consider what the real purpose of a lighting fixture is, otherwise you may be disappointed as was an old gentleman who got electricity on one of the early REA-financed lines. He wired his home and, during the depression, spent $20 for a living room fixture of a very beautiful multiple-bowl cluster type. A few days later he went back to the dealer who sold him this fixture. "There's something wrong with that light; I can't hardly read my newspaper by it," he complained. Lighting fixtures are chiefly intended to provide general illumination, but some special types may also provide light for certain close seeing tasks. Examples would be the lens type of dining fixture or a kitchen globe over a sink.

1. General purpose lighting: Ceiling fixtures provide general lighting in a room. They supply the softening effect or "sky area" necessary to well balanced lighting. General illumination furnishes light for moving through a room, for games, for talking and listening. It adds light for close seeing tasks which are done under portable lamps. The ceiling fixture provides a uniform light which coordinates or ties together the light from all of the lamps in a room. Fixtures give general purpose lighting for convenience, safety and greater eye comfort.

*International Commission on Illumination.

Below are some of the many uses and advantages of ceiling fixtures:

Cheerful light on entering room after dark
Added safety for walking in rooms, halls, on stairs
Additional light for close-seeing tasks
Background lighting for lamps to avoid contrast
Enough light for listening to radio, talking, resting
Fairly even light in center and corners of room when used with portable lamps
Usability of game tables in center of room
Pleasing atmosphere for guests on festive occasions
Flexibility in room's atmosphere and arrangement

General lighting is measured on a plane 30-inches from the floor at a number of places--should be at least 1/10, preferably 1/5-1/3, of local lighting.

Some of the main reasons for having a ceiling fixture are that it:

Provides even general lighting cheaply
Increases center-of-room lighting
Decreases annoying contrast in room
Provides balance in lighting more easily
Provides balance in lighting more cheaply

Substitutes for a central ceiling fixture might be:

Numerous portable lamps lighted in room
Wall brackets in pairs and balanced locations
Valance light and over-furniture lighting
Cove lights or other architectural lighting
Combinations of any or several of above

2. Special purpose lighting: Portable lamps usually provide light for close seeing, especially in living (activity and rest) areas. But some kinds of permanent fixtures are sometimes used for certain close seeing tasks, especially in work areas and bathrooms. Either ceiling fixtures or wall brackets are often used over work areas or at the sides of mirrors in addition to a center ceiling fixture. You will find this very satisfactory in such rooms as the kitchen, laundry, utility room or bathroom. For example, either a small ceiling fixture directly above or a wall bracket over the sink or better still built-in soffit lighting will give more light for dishwashing. Portable lamps also may give added light needed for close seeing tasks, even at work areas. While we do not often think of them as portable lamps, there are many portable pin-to-wall fluorescent lamps on the market.

The reasons you need local light for close seeing are:

Pupil of eye shrinks when looking at fine detail
Smaller pupil requires more light to see as well
Ceiling fixtures are far from task and rarely designed to provide enough local light
Your shadow decreases light available on task

Portable lamps and wall brackets are common means of furnishing added light needed.

The various types of wall brackets available are classified as follows:

Fluorescent or incandescent
Utilitarian or decorative--or combination
Uplighting, downlighting, or distributing; or
indirect, semi-indirect, general diffuse, direct

Brackets are useful for numerous purposes. Below are some of the common characteristics and uses of wall brackets:

Furnish light for close seeing work
Contribute to general lighting in area
Utilitarian--kitchen, workroom, bathroom
Use 40 or 60 watt incandescent, or
15-40 watt fluorescent tubes
Decorative--candle, hurricane and indirect
Serve as decorative feature--25 watt
Contribute to general lighting--40 to 60 watt
Reduce contrast by lighting wall
Combination--useful ones in living areas

Bracket fixtures have certain disadvantages. They are that brackets:

May be source of direct glare
May interfere with furniture arrangement
May interfere with picture arrangement
May produce annoying wall brightness
May be costly to buy and to install
Are not easily movable to another house

3. Decorative attractiveness: In addition to providing general lighting and light for close seeing, fixtures and brackets may add to the attractiveness of a home. If they are chosen for suitability to their purpose, and for design and color which harmonize with the furnishings and the house as a whole, they can be a welcome addition to a room.

Points to Consider in Selecting Lighting Fixtures

In selecting lighting fixtures, consider the amount of money you have to spend, the lighting need, the illumination qualities of each fixture, its appearance, its construction and its safety approval (U.L.).

Amount of money to spend:

1. Long-time purchase: Buying fixtures for a home means the expenditure of a considerable amount of money. While some people may change fixtures frequently, most are not apt to do so. Therefore, it is important to make a good selection first and spend the money you have wisely so that a change is not needed very soon.

2. 2-3% of cost of house: In normal times, home management specialists teach that you should invest 2 or 3 percent of the total cost of a house in lighting fixtures and about the same amount or a little more for wiring. This gives a starting figure* with which to work. Remember that most ceiling fixtures will not give enough light for reading and other close seeing tasks. With a few exceptions, they provide only general illumination. For close eye work, you need portable lamps or in some places brackets or special built-in installations in addition to fixtures.

3. Need for portable lamps: There must be money left after buying fixtures for the purchase of a number of floor, table and wall lamps. If funds are limited, it takes careful planning to get both general illumination and special lighting for close seeing. General lighting is necessary, but lighting for close seeing is still more important. If money is limited, you may want to buy simple, inexpensive, inconspicuous ceiling fixtures or even adaptors and save enough to have plenty of good portable lamps.

Enough light--quantity: In buying lighting equipment keep in mind its efficiency in relation to the amount (quantity) and kind (quality or comfort) of lighting produced. The light output in relation to the amount of electricity used is an important point to consider, but not so easy to determine when buying a fixture.

1. Efficiency of large bulbs: In the selection of a lighting fixture remember that for both quantity and quality larger light sources (in fixture size and wattage of bulbs) are a better buy than smaller ones. Longer, larger diameter fluorescent tubes are better in efficiency, brightness and light spread than equal wattage in smaller diameter, shorter ones. Larger incandescent bulbs are more efficient than smaller ones. One or two large incandescent bulbs in a single bowl fixture are more efficient than many small ones in a multiple-bowl or cluster type of fixture, though the latter may be desirable because it spreads the light over a wider area. Think of the comparative cost of the bulbs and the electricity they use.

2. Light colors, light metals: Remember that the color of the reflecting surfaces of the surrounding equipment affects the amount of light that you receive. A fixture with an ivory or white reflecting surface around the light source will give more light than an identical design with darker surfaces. Colored translucent glassware will distort the color effect in a room and generally produce less light than the same fixture in etched and/or white ceramic finish.

3. Distribution of light: The type of lighting used also influences the quantity of light you get from the electricity used. To get the same amount of light, general diffuse or semi-indirect equipment can use slightly smaller bulbs than indirect ones.

*See p 4 for reference as quoted from Peet and Thye's "Household Equipment."

4. Incandescent bulb wattage: This point is discussed in the following part of this section under quality. Changing to a higher wattage bulb increases the amount of light which in turn increases brightness of equipment. Then the size bulb becomes chiefly a quality or comfort problem. The main point to remember is to get as large a fixture as you think will look well, the larger the better from a lighting viewpoint, provided it is well designed.

5. Variable amounts of light: You sometimes find fixtures using three-light bulbs. There are some dining room and kitchen fixtures like this to give different amounts of light for different tasks. Fixtures giving variable amounts of light are desirable if you need both a low and a high light level. Choose equipment using 100-200-300 watt bulbs in Mogul sockets for larger dining rooms and 100-200-300 or 50-100-150 watt ones for dinettes. The higher wattage fixture gives enough light for some close eye tasks, especially if over a narrow table. If high wattage only will be used, buy fixture with single-position switch. Use more efficient one-filament bulb of top wattage.

6. Fluorescent tube wattage: Using a total lower wattage is possible in fluorescent installations because fluorescent equipment is about three times as efficient as incandescent. Following IES* recommendations below for minimum total fluorescent ceiling wattage for different rooms will help to get enough light in the room for general lighting:

Kitchen	80	Dinette	60	Laundry (direct type)	40
Dining room	80	Bedroom	40	Bathroom brackets	15-20
Living room	80	Bathroom	30	Mirror brackets	20-40

The small dinette, small bathroom and bedroom under 100 square feet might use the 32 watt circular fluorescent tube.

Two wall lights or brackets give a more desirable amount of bathroom mirror lighting, especially for under-chin shaving, than one light above the mirror. However, if you can have only one mirror light, choose a 15 or 20 watt shielded above-the-mirror fluorescent one. Or better still get a shielded 2-tube, 20 w fluorescent fixture which furnishes both uplighting and downlighting. See "Contents" for section on "Research on Lighting Home Activities."

Some of the characteristics of a good fluorescent ceiling fixture given below deal with quantity, others with satisfactory performance.

A Good Fluorescent Ceiling Fixture has:

At least two tubes--shielded from eyes
End shields of glass, plastic or slit metal
Device for controlling radio interference
Certified auxiliary equipment--starter, ballast

Fluorescent equipment is discussed in greater detail in the section on "Choice, Use and Care of Light Bulbs and Tubes."

*These suggestions are connected with specific equipment. See drawings and captions "Recommended Practice of Home Lighting," Illuminating Engineering Society, 51 Madison Ave., New York 10, N. Y., June, 1945.

7. Efficiency: Efficiency in lighting is important to you financially. It can be accurately figured by lighting engineers from the formula below:

$$\text{Efficiency} = \frac{\text{Light given by fixture}}{\text{Light given by bulbs in fixture}}$$

However, the consumer is unable to determine efficiency of equipment except superficially by its appearance.

8. Summary points: Below are a few buying guides to keep in mind.

Single large light bulb instead of many smaller ones in incandescent equipment (bowl vs. cluster)
Longer, larger diameter fluorescent tubes preferable to smaller ones of same total wattage
Translucent shielding, or translucent with opaque usually preferable to opaque for efficiency
White or light colors, light metals, dull finishes best (avoid deep colors--blue, green, rose)
Reasonably permanent reflecting surfaces
Shallow rather than deep bowls surrounding source; deep, narrow, orante designs usually trap light
Shading to give 30-50% more light below, where needed
Easy maintenance features--cleaning, relamping

Comfortable lighting--quality: The most important thing to consider in the selection of a lighting fixture is the quality or comfort of lighting given by that fixture. To determine comfort of lighting before buying the fixture, see the fixture lighted.

1. Appearance--lighted: The fixture should be lighted with the size bulb or bulbs you will need in the place where you are planning to use it in your home. In dealers' show rooms often small bulbs are put in fixtures. If you are seriously considering buying a fixture, ask the dealer to put in the size bulb or bulbs which you intend to use. You can ask the dealer about this or find what size to use in lighting bulletins.

Try the fixture with all others off, then you can judge the comfort of the lighting it gives with the proper size bulbs. Is the light evenly distributed, or is there a spot indicating the location of the bulb? Is it easy to look at the fixture when it is lighted, or does it appear too bright? Think about it installed against the background color in your room. Will it appear too light or dark against your ceiling or walls? What effect will lamps or other lighting equipment to be used with it in the room, have on it?

2. Fixture size: The diameter of a round fixture should be at least as wide in inches as the width of the room in feet, or preferably at least as wide as the room diagonal in inches. The width should never be less than 12" in any main-used room. The larger the size or area of the glassware the less its brightness and the more comfortable lighting it gives. In brief, the larger the fixture is, the better it is, and also the more fashionable.

3. Size bulb and bowl: The size of the bowl or reflecting surface should be large enough for the size bulb needed inside it, otherwise, the brightness is too great. For halls and storage rooms you can use as a minimum basis in your figuring--"one watt per square foot of floor space" to determine the size incandescent bulb or bulbs needed in a ceiling fixture. Thus, a hall 4 by 15 would have 60 square feet in it and would use at least a 60 watt bulb in its ceiling fixture. Higher wattage would be better, for example a fixture with three 40-watt bulbs is recommended*. "Two watts per square foot" is suggested for utilitarian fixtures in work rooms. And to this add local light at main work areas. There is also a relationship between fixture size and size incandescent bulb that is to be used in the fixture.

In single-bulb fixtures, incandescent bulb wattage should correspond with fixture diameter as follows:

Relation of Fixture Diameter to Incandescent Light Bulb Wattage

Fixture diameter in inches	Lamp bulb wattage in fixture
3½	40 or 25
4 or 5	40 or 60
6 or 7	60 or 40
8 or 9	75 or 60
10	100 or 75
12	150 or 100
14	150 or 200
16	200 or 300
18	300 or 500
22-24	750 or 1,000

The wattage given first above is the more desirable one but the second one may be used depending on the glassware and the background color. Wider diameter fixtures (16, 18, 22, 24) can use lower wattages than those given above. The figures given opposite 18", 22" and 24" fixtures apply to non-residential interiors. Wattage for home use would not be higher than 300 to 450 watts.

4. Line of view: You should take even greater care in selecting a fixture like a bracket fixture which is in your line of vision than one that is out of the line of view. A ceiling fixture can be brighter than a bracket fixture because it is out of your line of view.

5. Little shadow and glare: Two other things to watch for in selecting a fixture are relative freedom from shadow and glare.

Some fixtures are so mounted on the ceiling that the mounting bases or ornaments around the rim throw shadows. Such fixtures distract attention, especially in large rooms with a long view of the fixture. Very shiny mounts or ornaments do the same because of reflected glare. Fixtures should be free from direct glare or unevenly lighted (spotty) appearance. Also remember that bare or unshielded bulbs should not be used in fixtures any place in the home except perhaps in closets and unused parts of attics or basements. Therefore, buy fixtures with shielded bulbs and have the shielding large enough, thick enough and deep enough for size bulbs used.

Some indirect fixtures contrast too strongly with a light ceiling. When lighted, they make a brightly lighted spot with a dark fixture shadow against the ceiling. A slit or lighted section in the fixture helps eliminate this. Light comes through the slit or glassware inset and illuminates the fixture.

Also avoid choosing a fixture with a dark, non-luminous part on the luminaire, if next to or surrounded by very luminous portions. This is especially true if the size of the non-luminous portion is large or very dark compared with the rest of the fixture.

Large, very shiny sections are also undesirable for these attract your eyes to the fixture and distract your attention from your work.

6. Background for fixture: If the fixture is to be used against a dark background, you should also take special care in selecting the fixture; the bowl should be larger and more dense, or darker, than it would otherwise be.

Larger fixtures and more dense ones usually give better quality lighting and appear to be of lower, more comfortable brightness. But a fixture can be so dense that it wastes an unnecessary amount of light.

Avoid dark colored, totally indirect fixtures contrasting sharply with the ceiling. The dark outline of a lighted indirect fixture is often unpleasing against walls or ceiling. Also uncomfortable is bright, direct light from a direct lighting luminaire against very dark walls or ceiling. You might try a dense translucent fixture for these places. Or change the background color.

7. Summary: A brightness check which you can use in buying fixtures is:

Visit fixture display in late afternoon on dark day
Request the dealer to put proper wattage bulbs in fixture
Turn off all other fixtures in display room
Observe fixture for brightness of bowl
Note trim and design--are they annoyingly bright?
Look at ceiling above fixture, fixture support
Think of effect and hanging height in your home
Consider color and value of background for fixture
Consider other lighting equipment to be used with it

Lighting performance: The relationship between amount of light and comfort is important. In considering the total lighting performance of installed equipment for particular tasks in your home, look for:

Footcandle values suitable for use of area
Higher in work areas--kitchen, workrooms, study center
Lower in living areas--activity and rest centers
Lower if several portable lamps furnish main light
Eye-comfort and eyesight conservation requirements:
Fairly even, pleasing distribution of light
Comfortable, fairly uniform brightness
(Avoid annoying chrome, glass cutting, spottiness)
Shielded light bulbs in normal line of view
Relative freedom from glare and shadows
Smooth light distribution on background area
, Pleasing against background, lighted and unlighted
Balance of distribution within recommended ratios:
Zone 1--amount varies with task
Zone 2--no greater than Zone 1; no less than 1/10
Zone 1. For task of high brightness and long
duration--preferably 3 to 1
Zone 3--no area less than 1/10 or greater than
10 to 1; can be 100 to 1 if not adjacent

Appearance: The trend in the style of lighting fixtures is more and more toward simplicity. Simple designs with graceful lines and small amounts of ornamentation characterize the newer fixtures. Most of the better ones are neutral in color or have color used in a very restrained manner, as a trim. The white or near white ones, usually of glass, are very commonly used and very acceptable in most homes.

A good fixture becomes a part of the room instead of standing out as something apart. It is in good proportion to the size of the room and so designed and hung that it does not interfere with the sweep of vision. It is attractive, both lighted and unlighted, and is so simple and free from shadow and glare that it is restful if you happen to look at it. It harmonizes with the fixtures in other rooms and with the style of architecture of the house. It fits in with the furnishings used in the room in which it is placed.

A summary of points to check for attractiveness in fixture appearance is given below:

Suitability for room's purpose--work, rest, activity
Appropriateness of decorative style to area of use
Size well-scaled in proportion to room
Simplicity in style, line and decoration
Harmony in color with background, surroundings
Neutrality in color for future color changes
in room decoration and furnishings
Effect of its own and other lighting on fixture, using
light bulbs of correct wattage for area, task, comfort
Light passing through fixture, avoiding spottiness
Provision of light with little glare, few shadows
Room-to-room unity or harmony among fixtures

Construction and finishes: A good fixture is well constructed both mechanically and electrically. It is reasonably firm and rigid in its construction and free of sharp or rough-edged metal parts. It meets the safety standards of the National Electrical Code. It should bear the UL (Underwriters'

Laboratories) label of safety approval, which shows it meets National Electrical Code requirements. Manufacturers of such equipment are listed in "List of Inspected Electrical Equipment" and supplements, published regularly by UL*.

A fixture should be well finished for long use. If it or any of its parts are made of a corrodible material, the metal should be covered over with something that will not corrode or rust. The finish should not peel or be subject to easy damage in installing the fixture. Lacquer coatings help prevent tarnishing of some metals, like brass. The fixture should be light enough in color and of a proper finish to give the greatest amount and most comfort possible in lighting, for the purpose for which used. Dull finishes and light colors and light metals on reflecting surfaces are very efficient in giving good lighting.

The fixture should be easy to assemble and easy and safe to clean. Most rural homemakers have had kerosene or other fuel-oil lamps too long to be very enthusiastic about something that is going to add cleaning problems. This probably explains why farm women like the simple enclosing globes and single glass bowl or metal basin type fixtures rather than those with so many parts to them, such as multiple-bowl cluster fixtures. And perhaps it also explains why so many rural people are enthusiastic about modern forms of lighting. However, it should be remembered that any type requires cleaning.

Incandescent fixtures, in addition to these points, ought to have standard sized sockets; or if they are the high-wattage, 100-200-300 watt three-light type, Mogul sockets. It is too much bother to hunt for bulbs with special sized bases to fit into fixtures. Choose fluorescent equipment for larger diameter tubes in preference to smaller ones. Below is a brief summary which can serve as a buying guide.

Look for:

- Good electrical construction (UL label)
- Firm and rigid mechanical construction
- Exposed metal parts free of sharp edges
- Non-corrodible material or durable coating
- Reasonably permanent reflecting surfaces
- Good finishes (not peeling or marring easily)
- Sufficient room for correct wattage lamps

Since fixtures require frequent dusting, washing and relamping for best lighting performance, maintenance should be simple--look for:

- Equipment which uses standard bulbs or tubes of suitable size and easily available
- Easy assembly, installation and lamping
- Easy cleaning--dusting, washing--and relamping
- Enclosed type, open-bottom or silvered-bowl equipment for places where cleaning may be neglected

*Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago 11, Ill.

Room by room types:

1. General lighting fixtures for living areas: Numerous publications show pictures of some of the common fixtures for the various rooms. Notice how often you see the simple glass bowl or metal basin type fixtures for living or dining rooms and bedrooms. If you do any reading around the dining room table, you may want a special fixture with a large shade and hanging from a chain. There is a 10" bowl inside of this shade and a three-light bulb. This type of ceiling fixture, especially over a narrow table, provides enough light for some close seeing tasks. Another good dining room fixture is the translucent glass one with a downlight from a high-wattage bulb. A wide glass lens or circular louvered section improves and directs this light. Some of the very wide hat-like fixtures with the bulb or bulbs and shielding below the inverted bowl-like upper section provide good table light. They are very modern in appearance.

2. General lighting fixtures for work areas: Shielded fluorescent fixtures give good general lighting for work rooms. Well designed home-made ones suspended from the ceiling or on cabinets above counters give both general lighting and special lighting for cupboards and work areas. Large, medium thick glass globes and some semi-indirect fixtures of large size for high-wattage incandescent bulbs (150-200 w) do a good general lighting job here. The indirect silvered-bowl fixtures of larger size for 200 w bulbs give good general lighting in workrooms.

   In the laundry you can use a reflector type of fixture which has a white porcelain-enamel lining; this type of fixture gives direct light from incandescent bulbs, semi-direct light from tubes. It is especially good for a laundry that has an unpainted wooden ceiling. However, it would also be desirable to paint or whitewash the ceiling in this case.

3. Special lighting for work areas: With center ceiling fixtures you must provide bracket fixtures, portable lamps or an extra ceiling fixture above places where you want light for close seeing, unless your kitchen or laundry is very small. Long narrow fluorescent fixtures for the bathroom and kitchen give good lighting on either side of mirror, or they go under the cupboard or on the wall above a work space.

4. Special lighting for living areas: Bracket fixtures, which throw the light mostly upward are often used in work areas and occasionally in living areas. A few of these work-area brackets are of the enclosed type. The bulb is entirely surrounded by glassware. More often brackets are open-top types. Old style brackets of the candle type with bare bulb and pendant brackets of the open-bottom type are disappearing from use. If you have any bare bulb direct light or down-lighting brackets you should improve them. You can usually do this by turning over the glassware. In open top, inverted or enclosed brackets the bulb is shaded to minimize the glare. The newest decorative bracket fixtures are indirect ones made of metal, dense glass or plaster. These throw the light on the wall and ceiling above the fixture. This is the type used chiefly in living and dining rooms. If you wish brackets, choose light-colored metal, very dense glass or plaster ones. Consider those with larger areas, the plate-like ones in square or round shapes.

5. Careful choice necessary: It is necessary to choose bracket fixtures with very great care, to have them useful and comfortable. They are directly within the line of vision and are very annoying if they give poor quality lighting. For several good reasons, brackets are less commonly used than they once were.

Location of Fixtures

Ceiling fixtures: While formal balance in the placement of fixtures may be desirable it is not always necessary.

1. Central location: In the living and dining room, bedroom and most other rooms, you usually see ceiling fixtures placed in the center of the ceiling. However, in a very large living room, especially one with bays, or even in a long narrow room, two fixtures may be used, one centered in each end of the room. A room twice as long as its width needs two fixtures, or better still from an appearance viewpoint--valance, cornice or other built-in lighting.

2. Off-center location: A room with bays may have a fixture in each bay. In a living room, you may put a fixture over the table in the dining area. You may put ceiling fixtures off center in kitchen, laundry areas, baths, halls and on porches, if this placement will provide more light for such tasks as dishwashing, ironing, shaving or climbing stairs.

   Give special thought to the placement of fixtures on stairways; for safety, stairways should be well lighted. Avoid a ceiling fixture in which you can see exposed bulbs when either climbing or coming downstairs. Place the fixture so it does not throw shadows on the stairs, even if this may mean off-center placement.

3. Hanging height: In any room, the height of the room determines the type of fixture used and the method of hanging it. A fixture should not interfere with people walking through a room. Indirect and semi-indirect fixtures should hang low enough so that most of the ceiling will receive some illumination. A guide for hanging a chain-suspended luminaire is to have its light source center not more than 18" from the ceiling in an 8' 6" room unless the fixture is over a table. If these suspended fixtures are too close to the ceiling, there will be a bright spot on the ceiling above the fixture. This will attract attention and be unpleasing to the eye. If the fixture cannot hang low enough so that the spread of light will cover most of the ceiling, it should hang so that it will give a circle of light at least 6 feet in diameter. Some ceilings are so low that they will take only close-fitting, semi-direct fixtures. If the dining table is used for reading, and if a special fixture which looks like the top of a good floor lamp is used, it should hang no farther than 36 inches above the table. Over small tables, it may be as low as 24 inches above the table, and any type should not be more than 40 inches above the table, unless it is a ceiling recessed pinhole spotlight.

Location of bracket fixtures: Decorative brackets are rarely used now. This type of equipment adds cost and numerous problems to the lighting job and contributes little to the lighting result.

1. Decorative brackets: Hang decorative bracket fixtures in the living room or dining room with center of light source about 5 feet 6 inches from the floor except where the ceiling height or the design of the bracket call for hanging it lower or higher from the floor. Do not put higher, however, than 5 feet 8 inches, nor so low that glare from the source is directly in line of view.

   Place decorative brackets on opposite sides of the room and in balanced arrangement, one at each end of a wall space or on each side of a mirror, as in a hall. Wall brackets should be fairly near the door or window casements or at the ends of a long wall sapce. Place brackets so they will not interfere with furniture, picture and drapery placement and rearrangement. If you use them at all, install enough decorative brackets to provide balanced lighting as well as balanced arrangement in a room.

2. Utilitarian brackets: Put the utilitarian brackets used in the washroom, bedroom or bathroom for shaving and make-up, at a mounting height of just a little above 5 feet (5' 1" or 5' 2") for good under-chin lighting. In the bathroom, hang them about 30 inches apart so that light will be provided on each side of the face. If only one is used in the bathroom, put it directly above the mirror. This would have to be higher than 5' 2".

   Utilitarian brackets for lighting work areas may need to be 5' 6" high to get them slightly above direct line of view. Those under cabinets should hang at the front edge of the cabinet if possible. Since you may do many jobs, such as peeling vegetables or ironing, in a seated position, think of this when buying and placing bracket fixtures under cabinets. If it is at the front edge of the cabinet, it needs to be shielded from view. Placing the fixture at the front of the cabinet with the bare tube toward the wall rather than downward toward the counter may help solve this problem. Of course, buying a good glass or plastic shielded fixture would take care of it too, but this will add to your expense.

Purchasing Fixtures

Where purchased: You can get fixtures from wiremen, hardware stores, variety stores, electric shops and mail order houses. To see many different styles of fixtures visit your electrical dealers and their distributors' display rooms and mail order houses in larger towns. Your wireman or local electrical dealer will usually take you to his distributor's showroom to show you fixtures if he doesn't have any in stock or has a limited stock.

How purchased: Fixtures sell individually or in a group. Buying each fixture separately makes the fixtures cost almost twice as much as they cost if you can buy on the package plan. However, you have a greater choice when buying fixtures separately.

The package plan provides a group of fixtures to fit a small house for a unit price such as $19.95, $24.95, $29.95 or $35.95. In most packages, you get nine fixtures suitable for minimum lighting of a six-room house. All of these are shielded fixtures. There are fixtures for the kitchen, dining room, living room, front hall, three bedrooms and two porches. REA can furnish names of some manufacturers or distributors who make up these packages if your wireman or dealer doesn't know where he can get such fixtures. These packages provide considerably better lighting than the minimum bare-bulb installations sometimes made in houses. For a better lighting job, it is easy to use about 20 fixtures in a six-room house with bathroom.

How financed: An REA-financed cooperative can finance wiring installations and the purchasing of fixtures as well as most electrical and plumbing equipment, if it gets a Section 5 loan from REA.

These loans can be made for any amounts up to $1,000. Loans for fixtures or wiring may be spread over a 30 month period. They carry true 4 percent interest, or interest on the unpaid balance rather than the expensive finance-type interest. The member borrowing the money must pay at least 10 percent down on the cost of the equipment being financed.

Improving Installed Lighting Equipment

Home lighting plants: Many rural users of electricity had their homes lighted by home lighting plants before electricity came into the community. Many of the fixtures used with these are older fixtures of the undesirable bare-bulb type. Since 1935, conversion equipment has been widely available to help change over these and other older or poor quality lighting fixtures to newer and better lighting.

Adaptor equipment: The type of fixture used for change-over or modernization is called an adaptor unit. Adaptors and other shields range in price from 25¢ to $5 and occasionally higher for larger ones. You can screw these adaptors in where you have bare bulbs now.

Candle shades, other shields: There are plastic, parchment and fabric-covered candle shades and shields available to cover bulbs in various positions. These clamp on or fit over bare bulbs. There are some made to fit fluorescent tubes also. The fluorescent ones are of clamp-on or slip-on types. Such equipment is available in many of the same places as fixtures are sold, especially in the variety stores.

Bulbs: A cream-bowl, mushroom shaped bulb, used base up, converts many ceiling fixtures easily and cheaply. Silvered-bowl bulbs are also useful, especially the larger sizes in work areas.

Homemade units: The home carpenter can make plastic or wooden shields to hang below or fit in front of or around equipment.

Painting equipment: Many dark fixtures may become more attractive and efficient if you paint them white, ivory or some very light color.

Replating and buffing: Special shops in larger towns can clean and replate or refinish old metal fixtures to look like new. You may be able to clean

them yourself using salt and vinegar on copper or brass and polishing with whiting. In cases of badly corroded pieces, try home buffing equipment, fine sandpaper or very fine steel wool. Lacquer will keep copper, brass or silver from tarnishing again soon.

Changing fixtures: Fixtures should be changed instead of being improved in many cases. Often in remodeling or redecorating their homes, people spend a great deal of money but lose a lot of the effect of the improvements because old fixtures are left in place. Below are some of the reasons for making fixture changes:

Improvements in light sources take place
New materials develop
Styles of interior design change
Styles of fixtures change
Knowledge about lighting increases

Economy in Use

It is desirable to use fixtures and other equipment economically both to save money and scarce electric power. Also, where fuel is used to generate electricity, it helps conserve our natural resources. Some points to observe in economical use of lighting and related chiefly to fixtures are:

Use fixture when using only 1 or 2 lamps
to provide general lighting cheaply
Turn fixture lighting off if enough lamps
are in use to provide general lighting
Turn fixture lighting off in empty rooms
Clean walls and ceilings regularly for highest reflection
Heat water and cook with electricity to keep
walls free of combustion products causing light loss
Use light color for ceiling, walls, floors and
furnishings for efficient lighting
Remove dust on light bulbs and fixture regularly

Care: Good care of equipment improves the lighting in your home. Below are some guides:

Wash kitchen fixtures often to cut grease
Dust bowl fixtures every other week
Dust open-bottom fixtures once per month
Wipe all fixture parts affecting lighting
with damp cloth every other month, wash
well twice yearly
Wipe metal parts with damp cloth; dry well
Remove and wipe bulbs with damp cloth to clean; dry
Dust fixtures when you dust furniture

Summary

Ceiling fixtures are a necessary part of room lighting. For economical, convenient general lighting each room of the home needs a switch-controlled ceiling fixture with the possible exception of the living room where three to six lamps may be used, if operation cost is no consideration. When properly selected, ceiling fixture lighting gives pleasing general lighting in living areas for talking, moving about safely and entertaining. But mostly, ceiling lighting from fixtures adds to the lighting and helps eliminate annoying contrast of dark room center or dark corners when using light from lamps or brackets for close seeing tasks.

Buy ceiling and wall fixtures of proper size to shield bulbs of correct wattage, and get shielding of proper thickness and type so that the fixture is not too bright nor spotty when lighted. Often old fixtures can become attractive up-to-date ones which give good lighting by using adaptors or putting shields on the bare bulbs or tubes in them, or by refinishing them. Good and regular care of equipment and surroundings keeps these clean so the light reflects efficiently.

CHOICE, PLACEMENT AND USE OF PORTABLE LAMPS

Uses, Types, Parts

Uses and advantages of portable lamps: You can get light for close seeing easily from portable lamps. These lamps plug into convenience outlets on general purpose or 15-ampere circuits in any of the rooms of your home. Portable lamps have certain uses and advantages which make them desirable lighting equipment; they

Provide light for close seeing tasks
Add to general lighting in room
Add decorative interest in room
Permit easy movement of light source
Permit easy cleaning of lighting equipment

Types of portable lamps: There is a wide variety of portable lamps available including the more common ones below:

1. Table lamps: There are various types of table lamps for studying, ordinary reading, sewing and decorative use. One of the most important of these is a medium height incandescent (25") lamp suitable for use as a student lamp. Taller lamps (around 28"--26 to 36") are made for use on end tables; a few with circular fluorescents around bowls; others with large bowls like floor lamps. Another type may be clamped onto a desk. Very small lamps (under 18") are suitable for decorative purposes only. Few modern table lamps are shorter than 25", however, except for some fluorescent desk models and a few bare-bulb 21" ones. Hurricane lamps (10-15") and other copies of early forms of lighting are purely decorative and often not very tall.

   Vanity lamps: (dresser or dressing table lamps) Vanity or boudoir lamps are a type of table lamp used in pairs on each side of the dresser or dressing table in a bedroom. The light in this type of lamp comes through the shade directly without having passed through a diffusing bowl first. In early CIM lamps, a disk was used below the bulb to lessen glare on shiny glass or varnished dresser or dressing table tops. This disk model is being discontinued now.

   Urns: Metal, pottery or china urns provide decorative lighting. You can use them on fireplace mantels, buffets, bookcases and pedestals. A urn containing a spot bulb used with a ceiling mirror gives good piano score lighting. Urns also are useful for picture lighting.

2. Floor lamps: Floor lamps also furnish lighting for close seeing. There are taller and shorter floor lamps, lamps with circular fluorescent tubes or incandescent bulb candles and thosewithout, bridge lamps and swing-arm lamps. Some lamps have stands where potted plants can grow. These plant lights are also available in table and wall models. Another novelty lamp is the fan-lamp. There is one type of indirect floor lamp which doesn't have a shade but a reflector or bowl of metal or thick glass or a combination of the two; it is called a torchere. Few floor lamps now are over 60" tall, or shorter than 56", with the exception of a few 40" ones used mostly to give light for sewing.

3. Wall lamps: Another type of lamp can be fastened to the wall with a brad or a slender nail a little heavier than a pin. This is known as a pin-to-wall or a pin-up lamp. Incandescent pin-to-wall lamps come in two sizes. The small one has either a 6" diffusing bowl, or a small 4-inch cone or cup bowl or no diffusing reflector. A newer type uses the white-indirect light, R-40 bulb. The large wall lamp has an 8" flared diffusing bowl or the smaller (8"-B) certified (CIM)* crown diffusing bowl. This larger type should fasten to the wall with a heavy picture hook, wood screws or a special hanger. You must also hang carefully the special wall lamps which provide flexibility in use: an up-down model, which raises and lowers for reading in bed, and a swing-arm model, which extends from the wall to provide light for several uses. Fluorescent pin-to-wall equipment is available for mirror lighting, picture lighting, under-cabinet and other use. Shields come with some of these or are available separately. While such a lamp is not usually thought of as portable equipment, it comes with a cord attached and is easily movable. Another type of wall lamp is the bracket lamp.

Bed-hung lamps: Two other kinds of lamps, neither of which give desirable lighting, are sold for bedroom use. These might be classed as wall lamps; however, both are bed-hung lamps used for reading in bed. One is a round spot-light type of lamp, the other is a longer bed-hung lamp consisting of a bare tube partly covered over with a curved reflector above it. Both of these direct light in a narrow area, and neither are desirable lamps for reading in bed.

Night lights: Another form of portable lamp which might be called a wall lamp is the night light, a small light which uses a 1, 3, $7\frac{1}{2}$, 10 or 15 watt bulb and plugs directly into a convenience outlet. It does not have a cord, but two prongs like those on an outlet plug.

A more complete listing of portable lamps would include the lamps below:

Floor lamps:
- General purpose floor lamp (junior & senior) 56-63"
  - Incandescent
  - Incandescent and fluorescent
  - Fluorescent
- Swing-arm floor lamp 40-59"
  - Incandescent (single arm)
  - Fluorescent (single or double arm)
- Bridge lamp (incandescent) 50-59"
- Torchere--incandescent 61-66"

Table lamps 10-36":
- End table, study & desk 18-36", usually 25-28"
  - Incandescent (plain & swing-arm)
  - Incandescent and fluorescent
  - Fluorescent (plain and swing-arm)
- Dresser or dressing table lamp (incandescent) 18-26"
- Hurricane 10-15"; girandoles or candelabras, 20-25"
- Urns 12-13"

*CIM means lamp approved by Certified Lamp Makers.

Wall lamps:
- Wall lamps (incandescent)
- Brackets
  - Incandescent
  - Fluorescent
- Bed-hung lamps
  - Incandescent
  - Fluorescent
- Picture lights
  - Incandescent
  - Fluorescent
- Small night lights 2-4"
  - Incandescent
  - Gaseous glow light

Classification of lamps: Lamps are classified, as fixtures are, for method of light distribution used:

Direct--lamp with metal reflector or metal shade, shade closed at top, for example gooseneck and fluorescent desk lamps. Rarely recommended.

Semi-direct--bare-bulb table lamps, also a few floor models. Recommended only for sewing on dull materials.

Semi-indirect--most common type, has diffusing bowl inside shade. Used with proper wattage bulb, satisfactory for many tasks.

Indirect--indirect torchere or urn and portable metal wall brackets.

Parts of lamp: The main parts of a good portable lamp are:

Shade and finial
Base--bottom part on which lamp stands; felt pad
Stem--also called shaft, stand or standard
Pipe thread--raceway for cord; not necessary with hard wood or non-inflammable materials
Switch, socket or lampholder, lamp cord, wall plug
Diffusing bowl with incandescent bulb
  Incandescent one-filament standard base bulb
  Incandescent two-filament, standard or Mogul base
Bowl--with circular or straight fluorescent tubes
OR, wide harp and indirect-light bulb without bowl
OR, fluorescent tube, ballast, starter, lamp mounting
Various fittings--lock nuts, washers.

DEVELOPMENT OF CERTIFIED FLARED-BOWL LAMPS

Development of IES lamps: Since 1935 good portable lamps have been on the market. You may have heard a great deal about these certified better sight lamps, known first as IES* and later as CLM* lamps. The history of the development of IES lamps is an interesting one and serves as a background for present-day certified (CLM) lamps. The IES lamp certification program was introduced in 1934 and discontinued in 1944. The CLM or certified lamp program was ready for release shortly after the end of the war, or around 1947. There were many steps in the development of IES lamps.

1. Illuminating Engineering Society: The Illuminating Engineering Society, for which the IES stands, was formed in the United States in 1906. It is a professional group of lighting engineers and scientists. Illuminating Engineering societies were formed in England, France and Germany after the founding of the society in the United States. The professional transactions in local and national meetings and the society's monthly magazine, Illuminating Engineering, play a large part in any lighting improvements. There were 47 sections and chapters and over 7,000 members of IES in 1950.

2. Need of a new lamp: In 1932 the problem of a rapid increase of eye defects during college years came to the attention of some members of the Illuminating Engineering Society. The chairman of the school lighting committee became personally concerned when he went with his daughter, who was entering an eastern school as a freshman. The study lamp provided for her use was a lamp of the poorest quality. In addition, the college had set strict limitation on the number of watts which she and her roommate could use in their room. He was able to have wattage limitations raised a little. But he was unable to find a lamp that would give a satisfactory light for study purposes within the new limits.

   On inquiry it was found that this situation was common in several colleges. During the school year 1933-34, many colleges made studies of college lighting conditions. The IES was giving serious study to the problem of designing a lamp suitable for study purposes and reasonable in wattage requirements. As a result of this, a wholly new type of lamp developed.

3. Better Light--Better Sight drive: So much interest was aroused in better lighting that lighting leaders suggested a drive on Better Light For Better Signt in March 1934. Since many different factors entered into good lighting, it was finally decided to include other interests, such as the paint and varnish industries, in this lighting improvement program.

4. IES student lamp showing, May 1934: Meanwhile the first IES lamp was developing. In May 1934, this lamp which was a table reading lamp was displayed at the Traymore Hotel in Atlantic City. It was a "skinny grandpa" of the later IES student lamp and present-day CLM lamps.

*IES - Illuminating Engineering Society, CLM - Certified Lamp Makers.

5. Testing system: An approved testing and tagging system was soon set up so that the public might have some way of telling one of the better sight lamps from an ordinary lamp. It was decided that a tag of approval should be used on any lamp meeting the 54 specifications which the Illuminating Engineering Society had set up. Manufacturers could send lamps, which they had made, to an independent testing laboratory in New York City to see if they complied with all the lighting and construction specifications. The Electrical Testing Laboratory checked IES lamps before they went into production and spot checked samples of IES lamps after they were manufactured. Professional people and others interested in quality lighting and consumer educational problems welcomed the development of this certified lamp.

   The orange and blue tag, which said "Certificate as to Compliance with IES Specifications," was the sign then of quality lighting equipment, as the orange and blue CLM tag is today.

6. Better Light Better Sight Bureau: During this same period in 1934 the National Better Light Better Sight Bureau was formed. It was made up of 19 associations either directly or closely connected with the lighting industry. A publicity campaign consisting of national advertising, magazine articles and work with the electric power suppliers gave widespread information on the new high-quality IES lamps.

7. White House lighting improvement: Further impetus to the interest in lighting came when the lighting authorities were publicly commended for the excellent work which they had done in improving lighting in the Executive Offices of the White House.

8. Annapolis experiment: President Roosevelt thought so well of the better lighting in the White House that he asked the lighting authorities to see what they could do with the lighting problem at Annapolis Naval Academy. Yearly many young men were failing to pass the physical examinations at the end of their training period because during their school years they had developed defective eyesight. All of these young men had passed rigid eye tests when they entered the academy. IES student lamps were so successful in decreasing eye defects at Annapolis that many colleges and universities followed the example, seeing that each student got an IES student lamp.

9. Increase in number of IES lamps: Public demand for the IES lamp became so great that the committee on portable lamp specifications found it necessary to expand the number of models to cover many types of lamps used in the home. All of the early IES lamps were very simple in line and design.

10. High award design lamp contest: In the late 1930's professional interior decorators began to demand that the soft desirable light found in IES lamps be made available to them in portable lamps which they might use in the homes of their clients. The IES lamps so far were not decoratively attractive enough for this type of use.

In 1938 judges chose twelve prize winning designs, suitable for different interiors, in a High Award Design contest for IES lamps. This contest was sponsored by the Illuminating Engineering Society, the American Institute of Decorators and the New York chapter of the American Institute of Architects. A whole new group of IES lamps came on the market. There were lamps suitable for colonial and English interiors. Lovely delicate lamps that gave good lighting were made to fit with fragile French furnishings. And there were attractive good quality lamps, suitable for use in ordinary homes that had lovely conventional or modern furnishings.

What were IES specifications: IES set up fifty-four specifications, covering all parts of the lamp. They were:

1. Shade: Sturdy in construction (support 25 lbs. on top for 5 minutes); of proper shape to give specified lighting results, determined instrumentally; fit securely on the bowl; give a wide spread of light; have a special white inner surface of high reflecting value.

2. Bowl: Sturdy; proper size, shape and thickness to prevent the bulb glaring through; brightness determined instrumentally; send right amount of light up and down; soften light to eliminate glare but also give specified amount of light with certain size bulbs; substantially mounted on the lamp.

3. Switch: Good contact and properly insulated to prevent shock or fire; capable of operating after turning on and off 6,000 times; show no leakage of electricity either on or off even after 24 hours in warm, moist air; connected to wire which goes to the contact in the center of the base of the bulb.

4. Socket: Approved by Underwriters' Laboratories (UL); solidly mounted so that inserting light bulb does not twist and injure the wires; socket linings continue to give insulation protection even after 24 hours exposure to moisture.

5. Frame: Base weighted so lamp will not tip easily - table model up to 10 degrees, and floor model up to 7 degrees without falling over; made so as not to injure wiring during assembly or after assembly; all materials which corrode covered with suitable protective coverings; fittings incapable of twisting, bending or pinching, parts properly centered.

6. Wire: Cord hole with proper bushing or polished smooth to prevent fraying of cord, wiring joints soldered and taped, all connections soldered, cord at least 7 feet long outside base, one of three specified types of wire or cord, of size large enough to carry

current properly without voltage drop, strands not larger than specified maximum size for flexibility, rubber insulation compound in it which will decrease the electricity carried by it, UL band at every 5 feet, fastened to base to prevent injury, base covered on under side if any connections made there, must not kink when bent, insulation must not break down after applications of 900 volts between frame and wiring.

7. Plug: Must conform to NEMA standards, made of material not easily broken, tips of wires in plug soldered for mechanical and electrical security, provided with finger grip neatly attached to cord, capable of sustaining 50 lb. weight or pull without loosening cord ends from the plug prongs.

8. Lamp in general: General excellence of mechanical and electrical features; no leakage of electricity through lamp with switch on or off; easy to assemble as shipped; throw a definite amount of light upward, a definite amount downward to give correct light on work as well as balanced illumination throughout the room; provide a special amount of light on book or newspaper in normal reading position--minimum of 30 foot-candle, 1½ feet from center line of table lamp; have total light output 75% of light output of bare bulb; give specified intensities of light at least five different points with minimum of 10 footcandles at normal distance from center of lamp where it is likely to be used.

Have total of 54 specifications, 29 of which are for mechanical features, 14 for electric safety and 11 for good seeing. Thirty-nine of these were invisible, so the tag was of great importance to the buying public.

Present-day flared-bowl lamps: In 1944 the Illuminating Engineering Society decided to discontinue authorizing Electrical Testing Laboratories to issue certificates of compliance with IES specifications to manufacturers. It also discontinued the use of IES insignia on certifying tags. However, many flared-bowl (IES type) lamps are still being manufactured. These do not meet all of the 105 specifications of CLM lamps but are still good lamps for many flared-bowl lamps still meet the 54 IES specifications above. These specifications became part of the CLM program.

Different flared-bowl lamps have different sized diffusion bowls. These diffusing bowls are designed for different wattage bulbs:

Diameter of bowl	Wattage used
8 inches	100 watt
9-3/8 inches	150 watt, or 3-light 50-100-150
10 inches	300, 250, or 3-light 100-200-300

The proper sized bulb should be used in each of the different sized bowls in order to give the right amount and right kind of light. If too large a bulb is used, the diffusing bowl may become too bright. Too small a bulb will not give enough light at the distance at which reading or similar work is being done, and the light may be in the wrong position in the bowl.

Early IES lamps had high quality, thin, blown, opal glass diffusing bowls which gave good diffusion without wasting light. Later, some thick, low-quality bowls were made which wasted quite a little of the light. Both types of bowls are still available.

Ten flared-bowl lamp models available: There are ten models of flared-bowl lamps still available. These are listed below with their uses and the size bulbs they should have in them. Flared-bowl, IES-type lamps are still made by about 50 manufacturers and are widely available in many stores in all parts of the country.

1. Flared-bowl student lamp: For desk, library table, dining or kitchen table; uses 100, 150 watt or three-light 50-100-150 bulb. Early models were 28" tall; later ones built for wartime use were 25" high. Both heights are still available, the shorter one being better for children and short adults.

2. Flared-bowl end table lamp: In the early days of the certification program, manufacturers soon added a shorter lamp for smaller tables; it was 19-25" and used a 100 watt bulb. The trend now is to use taller lamps (25-28") for shorter tables; shorter lamps (24-26") for taller surfaces. Early lamps had rounded milky or prismatic bowls.

3. Flared-bowl desk lamp: Clamp-on type for desks; uses 100 or 150 watt bulb. This type is rarely found any more.

4. Flared-bowl (junior) study floor lamp: Beside chairs and davenports; uses 100, 150 watt or three-light 50-100-150 watt bulb. Sometimes called junior floor lamp, or study floor lamp.

5. Flared-bowl senior floor lamp: Taller, fits with larger furniture, taller rooms; uses three-light 100-200-300 watt bulb.

6. Flared-bowl swing arm lamp: Elbow or arm is adjustable and brings light source nearer; good with piano, desk or heavy stuffed furniture; uses 100 or 150, 50-100-150 or 100-200-300 watt bulb.

7. Flared-bowl bridge lamp: With smaller scale furniture; serves one seeing spot. Especially good for secretaries, tilt top desk. Uses 100 or 150 watt bulb or 50-100-150 watt three-light bulb.

8. Flared-bowl candle-type lamp: Similar to senior floor lamp. Has three candles with diffusing bowls on each. Used for sewing and reading; uses three-light 100-200-300 watt bulb and three 40 watt ones.

9. Flared-bowl torchere: Used for general illumination; shaped like an urn or a shallow round bowl; made of metal or dense, diffusing glass or a combination of the two; throws most of its light to the ceiling. Used in opposite corners or in balanced arrangements in living room and dining rooms, near pianos, in halls; uses three-light 100-200-300 watt or 250 or 300 watt bulbs.

10. Flared-bowl pin-up lamp: For the corner of a room, ends of a davenport, a telephone table, reading in bed, breakfast nook; used for study and at any places where floor or table lamp cannot be conveniently placed; should be located 30 inches from work and use 75 or 100 watt bulb in 6" bowl, or 100 or 150 watt in 8" bowl.

11. Flared-bowl dining room fixture: In addition, a flared-bowl dining fixture with a shade was and still is available. It may light the dining table satisfactorily for studying and some other rather close work, provided the table is narrow. A large dining table places the work too far away from this fixture. Narrow dinette tables are the only ones this fixture will serve for study. However, it is useful for casual reading or other less demanding eye work at large tables.

The lamps mentioned in 1 on the preceding page were built to Government specifications for Government use. Shades and bowls had IES tags, but lamps probably did not meet all IES specifications because of wartime shortages and problems. These lamps used 150 watt bulbs in either 8" waffle-glass or 9 3/8" blown glass flared bowls. They were 25" tall.

Nearly all of the present flared-bowl lamp models come with thicker, more dense waffle glass bowls than earlier models. Where 100 watt bulbs were suggested in the early period of the Better Light Better Sight program, 150 watt bulbs are now used. However, in a widely sold plastic 8" bowl, the manufacturer suggests using a 100 watt bulb. Too large a bulb sometimes causes plastic to discolor or become opaque. It would be wise to use the 9 3/8" plastic bowl designed for 150 watts for closer eye work. It may be that the smaller 150 bulbs in 8" plastic bowls will have a different effect than the longer larger ones. Glass bowls excel plastic.

Flared-bowl lamps are still widely available equipment. They furnish acceptable lighting for many tasks. While certified lamps are better, the distribution of them is not so wide spread.

DEVELOPMENT OF CERTIFIED (CLM) LAMPS

Development of CLM lamps: After the Illuminating Engineering Society decided to discontinue its certification and tagging program, in 1944, lamp manufacturers quickly decided to develop a new program.

1. Certified Lamp Makers: The group of manufacturers participating in the IES program organized and chose the name Certified Lamp Makers, and more manufacturers joined with them. They named an Advisory Board, set up a Technical Committee and chose a technical consultant. The presidents of leading lamp manufacturing companies serve on these committees. They are familiar with practical problems related to lamp design, lamp quality and sales appeal.

2. Study of portable lamps: The technical committee studied a wide range of lamps in deciding what should go into the specifications for certified (CLM) lamps.

3. Release of specifications: "Test Conditions and Requirements" and specifications for the lamps were released for final approval August 9, 1946. They were revised and changed as indicated below in 1950:

	1946	1950
Certified reflector floor lamp incandescent and fluorescent	45 ft-c	50 ft-c
Certified reflector floor lamp	30 ft-c	35 ft-c
Certified reflector swing-arm lamp	20 ft-c	20 ft-c
Certified reflector bridge lamp	20 ft-c	20 ft-c
Certified reflector table lamp, Type A 100-200-300 w bulb	-	40 ft-c
Certified reflector table lamp Type B, Incandescent & Fluorescent	-	35 ft-c
Certified reflector table lamp Type C	20 ft-c	20 ft-c
Certified reflector wall lamp	20 ft-c	20 ft-c
Certified dresser and dressing table lamps to side of face	20 ft-c	20 ft-c or more

4. Approval of specifications: The final draft of specifications for ten models of certified (CLM) lamps was approved in February, 1947 and revised in 1950. The specificiations cover other standards set up by various groups concerned:

IES Recommended Practices and Illumination Performances
National Electrical Code
Underwriters' Laboratories

5. Tagging of lamps: Before a manufacturer can tag a lamp with a CLM tag, the Electrical Testing Laboratories, New York City, must test and approve a working model for compliance with CLM specifications of two types:

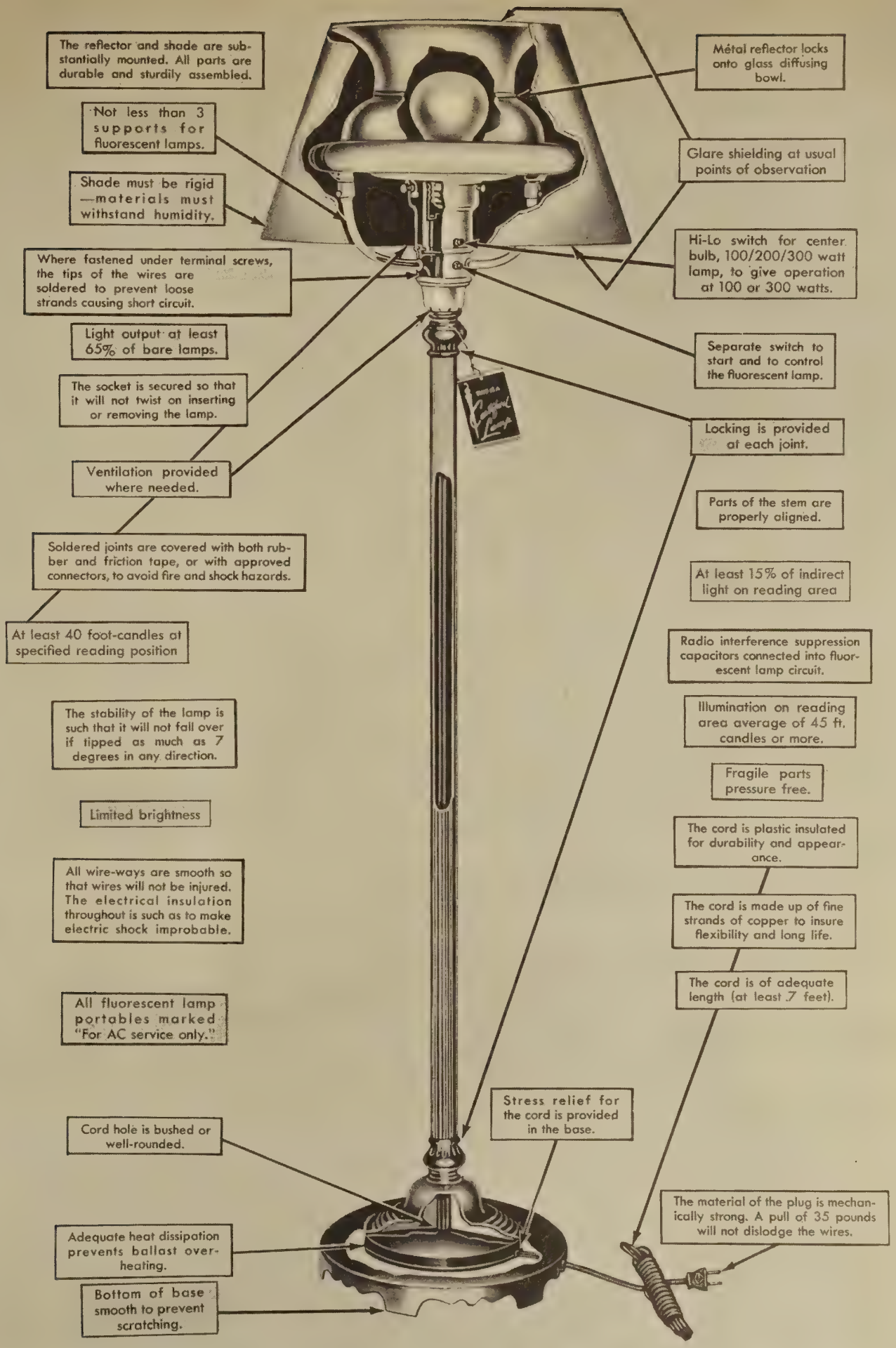
General Specifications	Individual specifications
Safety	Lighting service
Mechanical construction	Lighting performance
Electrical construction	Visual comfort
Lamp shades	Lamp positioning

6. Types of certified lamps: Certified (CLM) lamps meet 105 specifications: 20 on lighting performance, 37 on electrical characteristics, 48 on mechanical construction.

Type of Lamp	Approx. Ft-c	Model Bowl	Lamp Bulb Watts Used	Bulb Base	Approx. Height	Bottom Shade D*
Large floor I-F*	45-50	A-10"	100/300; 32 F	Mogul	58-60"	18-19"
Large floor	30-35	A-10"	100/300	"	58-60"	18-19"
Junior floor	20	B- 8"	50/150	Med.	56"	16"
Swing arm	20	B- 8"	50/150	"	56"	16"
Large table (A)	A-20-35	B- 8"	50/150; 100/300(A)	"	26-28"	16"
Large table I-F	35	B-8"	50/150; 32 F	"	26-28"	16"
Bridge	20	B- 8"	50/150	"	56"	13"
Table (Type C)	20	C-7½"	50/150	"	25"	16"
Pin-to-wall	20	B- 8"	50/150	"	48 & 8"**	13"
Dresser	20	Disk	30/100	"	22-26"	9-10"
Dressing table	20	Disk	30/100	"	15-20"	9-10"

*I-F, incandescent-fluorescent; D, diameter
**Bottom of shade 48" from floor; shade depth 8" minimum.

Three-light incandescent lamp bulbs with three contacts in 100-200-300 w, 50-100-150 w, and 30-70-100 w sizes are used with two or three position switches, turning the bulbs high-low or high-medium-low. The 12-inch 32-watt circular fluorescent tubes are used with the 3-light incandescent lamps in one model of the large floor and one model of the large table lamp. In newer CLM lamps, metal-crown diffusing bowls are replaced by all glass crown-type diffusing bowls in A-10" and B-8" sizes. The new B glass bowl replaces B and C metal-crown bowls.



The C. L. M. Lamp

A skeleton drawing showing some of the improvements which are required by the Specifications of the Certified Lamp Makers — verified by test and certified by Electrical Testing Laboratories, Inc.

What are CLM specifications: CLM set up 105 specifications covering all parts of the lamp. They are:

1. Stem and base: For vertical alignment, check rings and seatings held in place with lock nuts or other acceptable devices top and bottom; fragile stem parts not under pressure, pottery cushioned; stand straight with rim of reflector and shade level; proper base weighting for stability (table lamps tip up to 10 degrees, and floor lamps up to 7 degrees without falling); bottoms do not scratch nor overheat table tops.

2. Metal parts: Corrosible metals in lamp and shade frame covered; finishes must not peel, be easily damaged or mar in regular use. Bottoms will not scratch floors or tables, or parts injure persons.

3. Wiring - cord and plug: Points inside lamp smoothed or bushed to prevent injury to wire; stress relief in base to prevent insulation damage when pulling on wire; UL listing or label; not less than 7 feet cord outside of base; definite specifications for outlet attachment plug to give outstanding performance.

4. Switches and sockets: Fitter screws up-set to prevent being lost; switch stand 12,000 on-and-offs and still operate; switch operate several sizes of three-light bulbs. Manual starting switch for fluorescent tube to aid in preventing unnecessary temperature rises of ballast and bases (must not go over 110° F); design of switch to prevent leaving it on starting position and thus prevent overheating of ballast and abuse of fluorescent tube.

5. Auxiliary equipment: Ballasts must have certification by ETL; radio interference preventive (capacitor or condenser) for fluorescent tubes.

6. Shades: Non-corrosible or satisfactorily plated frame, joints welded (not soldered), top frame fitter thick enough to hold top wires securely in place. Shade tested under weights for proper strength at high humidity (85% and 85° F.). Rims - top and bottom - attached to shade frame by sewing, riveting or cementing. When cement is used it must not loosen under humidity-temperature test.

7. Glass diffusers: Standardized to fit all manufacturers' lamps; uniformly high transmission.

8. Lightmeter measurements: Test positions for lamps must conform to certain lighting performances requirements.

	Position in Relation to Test Plane Center		
	Straight Back	Right or Left	Ft-C
Table lamp on 25" table	16"	20"	20-35
Floor lamp - center of bulb	26"	15"	20-50
Wall lamp - shade bottom 48" above floor	26"	15"	20

All measurements made in unlighted room. Test plane - 14" wide by 12" high. Tipped 45° from vertical. Centered, 26", above floor. Test room 12'x12', with ceiling 8'6". Reflection factor: Ceiling - 75%; walls - 50%; floor - 20%. Plus or minus 5% is allowable on reflection factor.

Measurements of brightness with shade in place.
Within 2' of lamp and looking into top opening of shade
45" above floor and 3' out from shade
68" above floor and 2' from shade
Shade brightness of outside of shade
Shade brightness of lower inner surface of shade
34" above floor and 4' out from shade
Shade brightness - exterior surface
Brightness near bottom of shade

Measurements of brightness with shade off.
5 feet out and at 45° angle with horizontal
Minimum size of light source is prescribed.

Selection of a Portable Lamp

Selection points: In choosing a portable lamp consider the following points:

Visual comfort	Simplicity
Lighting efficiency	Durability of finishes
Usefulness	Sturdy construction
Cost	Replacement of parts
Beauty	Ease of cleaning
Decorative harmony	Safety approval (UL)

Need for lamps: Plan to have the proper lamp at the right place for activities carried on by each family member. Here are some guides:

Have shaded diffusing bowl or white indirect-light lamps to serve every chair, table, desk or area used for:

Writing	Reading	Knitting	Piano playing
Sewing	Drawing	Handwork	Other close work

Use shaded bare-bulb or disc*-and-bulb lamps or shielded fluorescent tubes at mirrors for:

Make-up	Dressing
Shaving	Manicure

Consider bare-tube fluorescents for shielded location over work counters and under cabinets.

Efficiency: In buying and placing lamps remember that more light in lamps comes onto work from:

Shade with wide lower diameter instead of narrow one
Flared instead of drum shades, unless CIM lamp
White or light shade lining instead of darker one
Medium tall table lamp rather than very squatty one
Short floor lamp rather than tall one--not too short
A lamp placed close instead of far away

Lamps should be efficient in providing both special or local lighting for close seeing and general lighting in the room for eye comfort when looking up from close work.

Base and stem: Choose a lamp with a fairly heavy base so the lamp will not tip easily. See that the stem centers on the base and that both are durable and fairly easy to clean. In buying lamps, examine bases and stems and consider:

Possibility of breakage with children in family of:

China	Glass	Plastic
Pottery	Marble	White metal

*These are being discontinued in CIM program.

Difficulty of removing scratches from following:

Wood	Plastic	Leather

Stains from handling light leather, unfinished wood

Durability of or ability to replace lacquer on:

Silver	Brass plating	Copper
Brass	Bronze plating	Other metals

Anodizing to prevent aluminum darkening

UL-approved cord--yellow band or marking on cord

Shade: The shade largely determines the attractiveness of the lamp. It also influences its efficiency and usefulness. In buying shades, choose shades which are:

Deep enough to hide light source
Wide enough to let light spread
Thick enough to prevent spottiness
White, dull lining for efficiency
White, ivory, pale yellow, light tan if unlined
Low brightness for television viewing
Open at top for general lighting
Certified for performance, construction
Proper height for chair and person nearby
with lower edge of shade at eye level

There is an interrelationship between lamp size, shade size, diffusion bowl and bulb wattage used. Below are given some common diameters of lamp shades and corresponding bulb wattages.

Type lamp shade	Diameter bottom	Bulb wattage 1-filament	2-filament
Candle or cluster	4- 6"	25- 60	
Dresser lamps	8-10"	60-100	30-70-100
Pin-to-wall	10-14"	60-100	50-100-150
Bridge lamps	12-14"	150	50-100-150
Swing-arm	14-16"	150	50-100-150
Table lamps	14-16"	150	50-100-150
Table lamps	16-18"	150-300	100-200-300
Floor lamps--Sr.	16-20"	150-300	100-200-300
Floor lamps--Jr.	14-16"	150	50-100-150

Diffusing bowl: The diffusing bowl in a lamp provides the good quality lighting you get from lamps. It does this chiefly by making the light source larger and more comfortable. Purposes of diffusing bowls in lamps are to:

Improve the quality of lighting
Avoid direct, harsh glare from source
Reduce reflections from shiny surfaces
Soften shadows in surrounding area
Direct the spread of light

Relation of bulb to bowl diameter: In portable lamps--bulb size corresponds with diffusing bowl diameter as follows:

Diameter of bowl (Flared, IES-type)	Lamp bulb wattage (one bulb)	Type of portable lamp
3½-4½"	40- 60	Candle cups
6"	75-100*	Pin-to-wall, table
8"	100-150*	Pin-to-wall, study, table
9 3/8"	150, 100/300*	Study, tall floor
10"	100-200-300	Floor, table
(Crown, CIM-type)		
A--10"	100-200-300	Floor, table
B--8 & C**--7½"	50-100-150	Table, pin-to-wall, floor
Disc**	30-70-100	Dresser, dressing table

Size and finish of bulbs used: A table reading lamp for studying or other prolonged close eye work should have a total wattage of at least 150 watts. For casual reading and short period use, a table or wall lamp may use as little as a 100 watt bulb. A floor lamp should have a wattage of at least 150 watts. A shielded 150-watt bulb or white indirect light R-40 bulb is a minimum requirement for prolonged close eye work. Many floor lamps and a few table lamps use the 100-200-300 watt three-light bulb, which furnishes greater quantities of light. For prolonged, difficult close-seeing work, you need the added light from a 32 watt circular fluorescent tube around the crown diffusing bowl or three 40 or 60 watt shielded candles around the flared bowl.

Bare bulb portable lamps or lamps without diffusing bowls are satisfactory only for decorative use or for hand sewing on dull materials; the reflection from the source is too bright for comfortable reading. Even the large white indirect-light R-40 or ceramic or silica coated white bulbs reflect too brightly from shiny paper to be used for prolonged close eye work, such as studying. Higher wattage white bulbs are satisfactory for hand sewing on dull materials, if they are used in properly designed portable lamps or other shielding equipment.

Decorative features:

1. Suitable to interior: The wide variety of certified, flared-bowl and white indirect-light bulb lamps now available makes it possible to have good lighting which is decoratively harmonious with whatever type of interior you have. Simply styled lamps fit well into the average home. Highly styled lamps giving good quality lighting may be used in more beautifully furnished or luxurious interiors.

   Certain things about the decorative fitness of lamps hold true in either case. The more fragile looking lamps are suitable with small delicate furniture. Medium-sized lamps fit on library tables and desks, while taller lamps go on end tables of shorter height. The scale of lamp should harmonize with the general scale of furniture used in interiors, and somewhat with room height and size.

*Plastic bowl may gradually discolor and become opaque if the larger size bulb is used.

**Metal crown reflectors with glass diffusing bowl and discs no longer available. New bowls used are all-glass crown bowls in two sizes only, 8" and 10". Diffusing units for A, B and C bowls are available as replacement parts.

The height of the ceiling and the size of the furniture has some influence on selection of lamp designs. Shorter, smaller-scale floor lamps go with low ceilinged rooms and lower furniture. They also give more light on work because they are closer to it than taller lamps. However in the flared-bowl types, avoid those so short that the bulb becomes a glare source to adults standing or walking in the room.

2. Arrangement changes appearance: The quality of lighting at a place where close-seeing tasks are done should not be sacrificed to decorative features. At a desk a medium tall lamp like the certified (CLM) 25" lamp gives good lighting. A taller 28" lamp is satisfactory for use by tall, erectly seated adults. You can shorten its appearance by balancing the taller lamp with some books, a globe, a horizontal picture or flowers nicely arranged. A tall lamp appears shorter if its stem is broken by a bulbous design. Currently, however, medium tall and tall table lamps are more fashionable than the short, squatty ones used before World War II. The tall ones go well on shorter end tables, as a 28" lamp on a 25" table.

Harmony between lamps and with room: Harmonious unity throughout a room can be secured by using several lamps of about the same height and with matching or blending shades.

1. Harmony in color: Close color harmony among shades and bases is pleasingly restful in a room. White and eggshell shades may be used together in very light surroundings. These colors can become a little bright when lighted and waste too much light through the shade for studying. Very light-colored shades may be too bright for television viewing even when bulbs are on lower wattages. And they appear too bright against dark backgrounds. Light tan, beige or light gray fit into most interiors. Neutral colors do not affect the appearance of other colors in the room as a colored shade might. Use care in buying and locating brightly colored and opaque shades. Think of the lamps together in a room when buying a new one. If it is at all possible, it is desirable to take the new lamp home and try it both lighted and unlighted before making the final decision to buy the lamp.

2. Harmony of shade materials: When several portable lamps are used, harmony among the materials used for lamp shades in a room is very important. Parchment shades or shades of a heavy weave or fiber, like linen, homespun or shantung, blend well together and fit in well with heavier, plainer, more modern furniture.

   Fine silk, rayon or antique metallic shades may blend into some interiors of the above type, but they usually fit better into more delicate or luxurious interiors and with period furnishings of more elaborate style.

3. Harmony in bases: The bases of lamps may help to carry out a certain idea in interior decoration or architecture. Simple copper, maple, pottery, and dull bronzes and more elaborate silver, shiny brass, and touches of crystal decoration all suggest different types of interiors and different uses.

4. Summary: For decorative harmony, consider the following when you buy your portable lamps:

Larger scale lamps for tall rooms, large chairs
Smaller or medium lamps for small scale areas
Taller lamps for low end tables (27-36")
Shorter lamps for desks, library tables (24-26")
Plain shades near figured draperies or walls
Shades harmonious throughout room in
Color--lighted Shade shape Height
Color--unlighted Shade material Size
Style of lamp base and shade harmonious with
architecture, furnishings, other lamps, fixtures

Fitting lamps into the room:

1. Number needed: It would be most desirable if there could be one CIM, flared bowl or white indirect-light lamp at each commonly used seeing spot. Conservative surveys show that the average home needs to buy at least five portable lamps. A five-room house usually needs a total of not less than 12 portable lamps.

The amount of money you have to spend, of course, will determine how rapidly you can add your portable lamps. With about $5 to spend, you might add a single flared-bowl student lamp, white indirect-light table lamp or wall lamp. With about $10 to spend, you can buy one of the CIM 25" lamps for study. It would be desirable to have three or four lamps in most living rooms, this would cost at least $20 if you buy the least expensive lamps. If someone in the family is handy with tools, you can get several homemade lamps for this amount. Lamp conversion may help your budget a little.

If you set your goal now and add lamps for Christmas presents and birthdays, you will be surprised how soon you'll have a well-lighted home. Of course, you will need to place them correctly and use them well to get good results.

2. Installation: As soon as you buy a lamp remove the cellophane to prevent heat and moisture from tightening it and warping the shade of the lamp. This may bend the frame of a fabric shade or wrinkle a parchment shade. Put the correct wattage light bulb in the lamp. Plug in the lamp and place the lamp properly with the cord out of the way of damage.

3. Location: Careful location makes it possible for a lamp to serve more than one person at a time. Bare bulbs or the diffusing bowl of a portable lamp should be out of the line of vision, and the light should be as close as comfortable and convenient to the surface being lighted. There should be no harsh glare nor sharp shadows on the work or in any position in the room. The light source to be out of your line of vision should be to the side or side and back of where you are working. Here are some hints on location of a lamp:

Place a lamp either to the right or left of the working surface. The rule about placing a lamp to the left applies for writing, drawing or

other similar hand work. This left-hand placement keeps shadows from falling on the work if the person using the lamp is right-handed. If he is left-handed, the lamp goes to the right instead.

Wherever possible the center of the stem of a floor lamp (or center below the light source in a swing-arm lamp) should be not farther than 30 inches diagonally back from the center of the working surface. This usually places the bottom of the diffusing bowl of a floor lamp about three feet from the work being done. The bowl and brightly lighted shade lining should be out of normal line of view. Having the stem even with the shoulder accomplishes this. The light meter shows the flared-bowl lamps with 150 to 300 watt bulbs at this distance give us around 20 to 30 footcandles of light, CIM lamps around 35 to 50 footcandles.

In a study lamp, the task center is 15 to 18 inches from the stem center and the diffusing bowl about 2 feet away. For end table lamps the stem centers about 24-26" diagonally back of the task center and a little in front of the shoulder. Sometimes it is possible to arrange the balance between chair, table and lamp height so that you can have a greater quantity and a better quality of lighting.

A good general rules to follow is to locate a lamp so that you get the most light and the greatest possible comfort. There should be no overly bright light source or brightly lighted shade lining in line of view; no glaring reflection of light from shiny paper or wet ink into your eyes, little shadows or glare on your work.

4. General illumination: Certified (CIM), white indirect-light and flared-bowl lamps throw some of the light to the ceiling as well as sending it to the working surface. Try to arrange portable lamps so that this general illumination is well balanced in the room. Placing lamps in opposite corners or on opposite sides or ends of the room is one way of accomplishing this.

Balance in arrangement: Balance in arrangement, whether it is formal or informal, is one of the most important features in fitting a lamp into a room.

1. Formal balance: Remembering how a teeter-totter board works helps us to understand and plan good balance. Two lamps exactly alike on end tables on each end of a davenport give formal balance and make a very pleasing arrangement.

2. Informal balance: Place a lamp in the middle and balance furniture on each side of it, or place furniture in the middle and balance lamps on each side of the furniture. In this type of arrangement, lamps need not be exactly alike. There should be, however, a similarity in the heights of the lamps and the size of the shades. With unlike objects arranged pleasingly, you have informal balance.

You can use large furniture, drapery or another lamp to balance a tall lamp. And in addition to balancing things decoratively, keep in mind that the light going upward in different parts of the room should balance

also. Lamps should be 15 to 18 inches from walls to avoid too great brightness on the wall above and below the shade. Or you should have plenty of general lighting or more translucent shades to help light the walls evenly.

The points below may help guide you in proper placement of lamps:

Purpose--to bring usable light near user
Placement--in relation to work being done
  Reading--light from left or right side
  Writing--light on side opposite hand used
  Handwork--avoid shadows on work
Placement--in relation to person
  Not in front of person unless shielded fluorescent
  Not directly behind person (produces a shadow)
  Lighted shade lining out of line of view
  Lighted diffusing bowl or bulb out of line of view
Placement--in relation to chair, or table, etc.
  Toward rear side of chair even with shoulder
  On edge of table near chair
  Centered on left side of blotter at desk
  Bottom of shade 26-30" above mattress at bed

Cleaning, Care and Economical Use of Lamps

Cleaning diffusing bowl: As a part of the regular weekly cleaning, dust glass diffusing bowls and bulbs in your lamps. Every other week, or at least once monthly, wash the bowls.

Follow these steps in cleaning glass and plastic diffusing bowls:

Disconnect lamp from outlet, or turn off
Remove light bulb from lamp when cool
Loosen screws and remove or unscrew, diffusing bowl
Wash bowl in warm soapy water; rinse well
Wipe glass of light bulb with damp cloth; dry
Dry diffusing bowl thoroughly inside and out
Examine socket; upend lamp to remove any bugs,
  or disconnect lamp and pull them out with
  vacuum cleaner
Replace bowl and tighten screws on socket
Replace light bulb; connect; turn on to check

Regular care of shades: As a part of the regular weekly cleaning of the house, clean the shades of lamps by one of these methods:

Brush with soft clean brush, or
Use shade cleaning vacuum attachment, or
Wipe off with clean bathtowel regularly
Wash brushes or towel before using again

Care of badly soiled shades: When shades become badly soiled, it becomes necessary to wash or dry clean them. Below are some suggestions on care of shades if badly soiled:

Dust with brush, vacuum cleaner or bath towel
Dry clean the following types of shades:
Glued silk Chintz Appliqued fabric
Glued rayon Linen Painted fabric
Wash stitched silk or rayon shades
Use gum eraser on fabric-covered paper
Wipe parchment, spun glass, plastic with sudsy cloth; rinse with clean, damp cloth; let dry
Remove cording, decorations from plastic shade before cleaning; clean separately; replace
Use plastic wax on plastic shades to lessen dust-catching problem of plastic material

Specialists of one state Extension Service suggest a cup of skim milk as a cleaner for a parchment shade. It seems to prevent soaking as water might if carelessly used. If there is so much soil that a second washing seems necessary, it may be better to let the shade dry thoroughly, then wash again.

Washing shades: You can wash a stitched fabric shade and make it look as good as new. Don't try washing fabric-on-paper shades for the fabric usually shrinks and warps the shape of the shade.

Here are the steps you can follow in washing washable fabric shades:

Dust with brush, vacuum cleaner or bathtowel
Fill laundry, bath or other large tubs with:
Lukewarm water and suds from mild soap
Lukewarm softened first rinse, other rinses
Lift or roll shades through suds one at a time
Brush with soft brush if very dirty
Use straight down strokes, top to bottom
Use circular motion around trim
Quickly rinse 3 or 4 times in clear water
Shake shade; pat gently with bathtowel; dry frame
Place over lighted lamp or use fan to dry

Remember that glued fabric shades may fall apart if you try to wash them. It may be possible to dry clean them successfully, however.

Caring for special shades: There is a wide variety of materials used in modern shades. Some of these require special care. But most of them you can wash. Below are a few hints on care of special type shades:

Leather--a little vaseline, once per month
Plastic--wash and wax with wax for plastics
Spun glass--wipe with damp cloth
Mica--wipe with damp cloth
Parchment--wash, do not submerge in water
Metal--do not use furniture polish
Wash with damp cloth; dry quickly

Reconditioning linings: You can improve badly soiled colored shade linings by cleaning and coating them with white shoe polish or paint, or by relining them. Relining is the safest way to improve any shade; coating will improve light reflection, but may show streaks in any except opaque shades, when the shade is lighted.

Below are the steps you can take to recondition linings of opaque shades:

Remove dust with clean dustcloth or bathtowel
Possibly wash with sudsy cloth, rinse, dry well
PAINT--use brush, or spray paint at home
(Protect exterior with paper held on with
masking tape) or have auto shop spray interior
If not oily--use 1 coat flat paint inside
If oily--use 1 coat shellac first, let dry;
use second coat of shellac, if necessary; then
apply 1 or 2 coats flat white paint; dry each
SHOE POLISH--coat with white shoe polish
WHITE PAPER--roll shade over white paper,
and draw pattern for shade liner. Cut liner
and attach with masking or scotch tape, or sew
NOTE--IT IS VERY DIFFICULT TO APPLY POLISH
OR PAINT EVENLY TO PARCHMENT; STREAKING
SHOWS WHEN LIGHTED EXCEPT ON OPAQUE SHADE

Caring for lamp bases: The purchase of a lamp represents an expenditure of quite a little money. Good care of the base along with the shade will make the lamp last a long time and keep it looking well. The base of a lamp may outlast several shades. Below are some suggestions on how to care for lamp bases:

Dust regularly with clean, soft cloth
Avoid scratching or rubbing harshly
Metal: Apply wax thinly, except on chromium
Washing or furniture polish ruin lacquer
Have corroded bases replated by plater
Avoid abrasives which scratch finish
Wood: Clean with furniture polish, wax
Leather: Use wax; clean with saddle soap--
may darken light leather. Have refinished
Others (glass, pottery, marble, onyx): Wash
with warm soapy water, rinse, dry
Don't get cord or socket wet. Wipe dry

Using lamps economically: It is important to use lamps economically in order to save money on your electrical bills and conserve natural resources used in making electricity in all areas except where water power is used. Below are some points on economy in use of portable lamps:

Turn lamps off in empty rooms
Use fixture lighting with 1 or 2 lamps
Place study desk so child faces wall or corner
Place a lamp to serve two or more people
Keep equipment clean to get 20-50% more light

Use white shade linings--50% more than dark
Use light-colored surroundings around lamp
Change light bulbs when blackening badly
Replace bulbs with proper size, type
Dust shade, bowl and bulb regularly

Remodeling of Lamps

Points to consider: Many rural homes contain beautiful old fuel-oil lamps. Others have lamps that were bought for home lighting plants. These lamps represent a considerable expenditure of money and frequently have attractive bases and shades. You may have some that you would like to keep in your home if you could improve the quality of lighting given by the lamps. Or perhaps you want to convert them for decorative use, instead of using them for close eye work.

In remodeling a lamp, consider several points: the place where the lamp is to be used; the height of the lamp; the lower diameter, shape, size, color and texture of the shade; diffusion of the light; decorative features; the size of the bulb that should be used in the lamp; and the cost of remodeling. Sometimes a poor lamp can be moved to a place where it will be used seldom. It may not need to be made over then. If this cannot be done, modernize the lamp--keeping in mind the size of the desk, table or area over which it is to spread its light. Consider the height of the lamp, especially in the case of table lamps. Some lamps are so short that they would be of no value except for decorative purposes even after having been brought up-to-date. However, it is possible to raise some of these on stands. If the base is over 11 or 12" tall, you can convert a lamp for close seeing purposes. Just remember that the bottom of the shade needs to be 15" above the table for study purposes. It can be about 17" above on an end table 25" tall or if used by a tall, erectly seated adult at a 30" desk.

Examine the shade of the lamp carefully. Is it wide enough? A reading lamp should have a shade not less than 12" in diameter, and a 12-inch shade is suitable only on a bridge lamp which can swing around close over the eye task. A table lamp should have a 14, 16 or 18" shade and a floor lamp a 16, 18 or 20-inch one. The height of the lamp then becomes important for, if the shade is changed, the whole lamp should look well proportioned when the larger, wider shade is substituted. In order to secure the same wide spread of light, a short table lamp usually needs to have a greater slant to its shade than a tall table lamp or a floor lamp.

Ask yourself about the shade: Is the design pleasing or is it overornate? Is the lining white or near-white, or is it so dark that it is going to waste a lot of light? Is the shade thick enough for the size bulb that should be used inside the lamp? Can a wide harp and an indirect-light bulb be used for conversion? Can a diffusing bowl be used to make over the lamp? Is it a good enough lamp from a decorative and material basis to spend the money necessary to make it over?

Methods of remodeling: Often you can modernize old type bridge lamps by screwing in a silvered-bowl bulb, a white indirect-light bulb, or by using special bridge adaptors. A larger shade will convert some old lamps satisfactorily; the new shade should have a white lining. Or maybe you can buy an adaptor consisting of a special socket and a diffusing bowl and install it in an old lamp. Sometimes you must remove and turn the bridge section over to do this. You turn the bridge section over for the white indirect-light bulb also. The base of the lamp must be heavy enough to support any additional weight.

To improve a shade with a dark lining or a too thin shade, paste a white lining in a parchment shade or sew one into a silk shade. The inside of some shades might be sprayed with a dull finish white paint by an auto repair shop. Paint or shoe polish is nearly impossible to apply smoothly to the inside of a translucent shade without showing streaks when lighted. Stippling or swirling with a sponge will improve some streaked shades. Any equipment used for remodeling a lamp should be tried out with the right sized bulb before it is purchased. You can usually do this in the store. If it is a shade, you may find it is too thin and is spotty looking when lighted. You can try a light bulb with a whiter coating in this lamp. Some diffusing bowls may be too thick and wasteful of light. There are thinner ones available.

Painting lamp bases: Many dark or chipped enamel lamp bases may become attractive and efficient if you paint them white, ivory or some very light color.

Replating and buffing lamp bases: Special shops in large cities can clean and refinish old metal lamp bases to look like new. You may be able to do this yourself with home buffing equipment, fine sandpaper or home cleaning substances, such as vinegar and salt or very fine steel wool. Lacquer will keep bases from tarnishing again soon.

Summary: Older IES portable lamp specifications covered 54 different points important in a good portable lamp. Certified (CIM) lamp specifications cover 105 points. The orange and blue CIM tag is a guarantee of quality lighting now since CIM lamps have superseded IES ones. These certified (CIM) lamps give better lighting than other lamps and cost little or no more. For good use remove the cellophane from the shade, use a large enough bulb, and place your lamps well to give plenty of comfortable and balanced lighting and to avoid shadows and glare. Keep equipment clean and use it in light-colored surroundings for greatest efficiency in lighting.

STUDIES OF LIGHTING AND SEEING FOR THE STUDENT AT HOME *

Research: Research reported in 1943 analyzes the lighting results from 20 representative floor, table and wall luminaires that are popularly advocated and used for home study. Two new luminaires for this task were designed and investigated.

The reports on luminaires tested include: 7 table lamps with shades, 5 desk lamps (4 fluorescent) with reflectors, 4 wall lamps (2 installations in pairs), 3 wall fixtures (2 fluorescent), 1 floor lamp.

Test conditions: Test conditions were carefully controlled and briefly included:

1. Test room: 12'x12' with 8'6" ceiling, similar to standard IES test room. Reflection factor of room - ceiling, 75%; walls, 48%; floor, 30%.

2. Reading matter test plane: 12" deep x 14" wide, centered 9" from desk edge. Locations - horizontal, or flat on desk; 30 degree tilt toward user. Mirror 12"x14" to test specular reflections, also 2" magnesium oxide plate.

3. Reading zone or desk top: 20"x38", 24"x46", 30"x50" - all 30" high. Finish of flat, non-glossy paint, 35% RF.

4. Relaxing zone: Celotex tackboard above desk (4'x6' warm gray, 55% RF, stippled). On the tackboard a circle 30 degrees in all directions from line of sight; and luminaire shade.

5. Eye position: 44" above floor; 14" above desk. Chair: 18" to seat.

6. Luminaire placement on desk. Floor lamp centered 15" from center of test plane and at desk edge. Table and desk lamps centered halfway between front and back edge at left and 12" to 15" from center of test plane. Wall lamps: used singly, 12" to 15" from center of test plane; in pairs, 30"-36" apart. Wall-mounted fixtures and some desk lamps were centered above test plane and forward from wall.

Test measurements: Measurements were made with lightmeter and brightness meter.

1. 5 readings on horizontal test plane.
2. 5 readings on test plane at 30 degree tilt.
3. Special measurements using black cloth over shade; black cardboard on walls to get indirect illumination value and ratio of direct and indirect illumination.

* A paper with the above title, written by Mary E. Webber, was presented at the 1943 National Technical Conference of the Illuminating Engineering Society and published in the May, 1949 issue of Illuminating Engineering.

4. Brightness measurements of luminaires and 5 points in relaxing zone at center and 4 points on circle drawn on tackboard above desk.

5. Specular reflection with mirror and 2" magnesium oxide plate. Readings of brightness of light source and inner reflecting surface of shade or reflector.

6. Block raised luminaire to preserve correct distance between light source and plane of measurement.

Placement of desk: Close-to-wall placement of the desk helps provide general lighting needed for comfortable visual field.

1. With a desk flat against a medium light wall, a good luminaire can light the desk and the visula field with little or no help from other lighting in the room.

2. A desk in the corner using reflected light from two walls gives greater amount of lighting on desk. It is particularly suitable if a window is in the left wall for daylighting. A drawn shade is necessary to prevent light loss here at night.

3. It is undesirable to have a desk facing a window because of distracting activities outdoors and annoying sky brightness directly ahead.

4. Right angle placement on the wall is suitable for a desk not used for long study hours.

5. Small size desk allows little room for study equipment and places student too close to wall. Large size is hard to light.

Placement of luminaire: Some points observed about luminaire placement for studying are:

1. For lighting it is best to center table or desk lamps even with the center of the reading matter test plane, about 9" from the desk edge. However, lamps look better placed halfway between front and back edge of desk, which is also a satisfactory location.

2. Placement of 15" from lamp center to work center should be maximum.

3. Long shielded fluorescent tubes give good lighting for study center if centered 6" or more (up to 20" over desk 30" wide) from wall.

4. Student needs lighted space for extra study materials - notes, books. Proper lighting equipment well placed will provide this.

Quantity of lighting: The average amount of light and variation in quantity across the 12"x14" plane representing reading matter showed important general factors to observe.

1. With reading matter flat on desk, most of the luminaires tested gave an average of 40 foot-candles, recommended for study, and several gave more light.

2. Average footcandles for tilted position, at 30 degrees toward person, showed marked loss and increased variation in footcandles across page. Tallest table lamp, floor lamp and center-placed luminaires gave best results in tilted placement of reading matter. Pushing book back from desk edge improves footcandle level and smoothness.

3. Propping reading matter up on a single book gives nearly as good lighting as flat placement, and it makes print appear larger.

4. Many lamps with shades closer then 15" to the table gave a wide variation in footcandles across the test plane.

5. A flaring shade helps reduce variation, and raising a short lamp on a block helps improve light spread and footcandle level at far side of reading matter.

Quality of lighting-luminaire: Some points noted on comfort of lighting from luminaires are:

1. Two luminaires or one long one placed over the desk center gave best lighting distribution.

2. There is no such thing as even illumination over reading-matter test plane; author recommends:

   Maximum to minimum ratio preferably not over 3 to 1
   Low reading should not be less then 1/3 of high

3. Design, form and finish or lamp bases should avoid annoying reflections of light source.

4. Outer shade brightness should not exceed 100 ft-L, preferably less.

5. Luminaire brightness should blend in with that of surrounding visual field. By being neither markedly greater nor less in brightness, it does not distract attention from the reading matter to itself.

6. If inner surface of luminaire shade is visible, its streak of brightness can be most harsh, especially with dark outer finish.

7. Opaque shades need general lighting, but this does not remedy extreme contrasts.

8. General lighting provided in most homes and by most fixtures is inadequate to balance lighting without lighting from local equipment.

Quality of lighting - in surroundings: Observations and measurement of brightness in the work surroundings revealed:

1. Recommended ratio of 3 to 1 between visual task and surroundings is suitable for the study center. Flat against wall or corner placement of desk is necessary to get this in most homes.

2. Improvement in comfort of brightness pattern comes from:

   Increase in indirect lighting
   Equipment with luminous shades
   Brightness of luminous shades should be 3 to 1 ratio with wall and task brightness

3. A good desk luminaire properly placed can provide 3 to 1 brightness ratio alone.

Reduction of glare: Reflected glare from glossy paper is distracting and trying to the eyes if the light source is too bright. Observations made in these tests were:

1. Light from other sources helps diminish specular reflections.

2. Shifting reading matter will often move annoying glare, but it cannot be entirely avoided with typical desk luminaires.

3. Placing luminaire directly in front of student need not always be unsatisfactory. The long fluorescent unit mounted over the desk is quite satisfactory. A diffusing sheet beneath the tube is desirable.

4. Placing luminaire at side does not avoid all reflected glare, just reduces its area. Putting it far enough to side to eliminate glare reduces quantity too much. Pulling luminaire toward front of desk decreases annoyance.

5. Polarizing materials, which function well within certain angles, help to reduce specular reflections but also reduce average illumination 50%. Their value for studying was questioned.

"The Studies of Lighting and Seeing for the Student at Home" have resulted in the very practical suggestions for the Home Study Center given in the next section. This material was prepared by Miss Webber and may serve as an outline for an illustrated lecture or demonstration by adult educational workers or 4-H members.

A PLAN FOR THE HOME STUDY CENTER

The following is a plan that spells good posture, attentiveness, and eyesight protection for the student:

The day of the hit-and-miss study location and lighting for it is past--or should and can be. The hours spent on home study assignments; the character of the eye task; the formative years in which home study is required; and their impact on the habits and the progress of our future men and women combine to establish the importance of a location developed especially for study. This must be planned and executed with a knowledge of all the elements which effect good seeing, good posture and mental concentration. Some of these individual elements have been often recommended. Only very recently have they been sufficiently correlated so that the following specifications for the planned home study center can be outlined.

Importance of a planned study center:

1. Over ten million students in this country have home study assignments, beginning usually at 8th grade level - often earlier - and extending through adult education groups.

2. Hours of required home study vary from 1 to 5 and occur during most of school year when artificial light is needed.

3. Learning acquired; eye-use, posture, attitude and habits formed in this period influence a lifetime.

4. Study involves critical eye-use, fixed position, concentration.

Existing conditions which indicate need of better study conditions:

1. Increase in eyesight defectiveness

   a. 10% in early school grades.
   b. 30% at college graduation.

2. Surveys show

   a. Prevalent use of low-wattage bulbs: They cannot possibly supply the amount of light needed for long periods of reading.

   b. Existence of few desk lamps suited to appropriate study lighting.

   c. Lack of desk space in high percent of homes forces hit-and-miss study location at dining tables, kitchen tables, and card tables, which are inadequate and impractical if not impossible of lighting satisfactorily.

   d. Retail outlets, including book stores, carry and promote too few satisfactory study lamps.

Contributing factors to comfortable seeing - exclusive of lighting

1. Desk

   a. Flat top desks or tables are preferred to drop-leaf types because they afford more work surface - are more easily lighted.

   b. A top surface about 24" x 48" is preferred - width not less than 20". Standard height has been 30" - though modern types available at 28" and 29" are more desirable for children and short persons.

   c. Finish of top surface should be non-glossy and of high reflectance (35% - 50%). Mahogany and other dark woods should be covered - at least in a sizable central working space - by pastel blotters.

      Recently desk-top linoleums (tan and green, approximately $4.00 a square yard) have been developed; they are ideal for renovating old desks or tables.

2. Desk placement

a. Flat against a wall (never in front of a window) and in a location somewhat removed from family activity and conversation. This placement, with correct wall treatment, provides more light from a given lamp. It assures best control of visual environment without dependence on other lighting in the room. Additional light from a fixture or other portable lamps is desirable but not essential with this placement.

b. Wall should be non-glossy - high reflectance (45 - 65%) free of high-contrast or "busy" pattern.

c. If wall is dark or patterned, a celotex (approximately 10 cents a square foot) tackboard approximately 36" x 42" may be hung on wall with its bottom edge even with the desk top. Wall lamps can hang on it.

3. Desk chair

a. Adjustable posture chairs are desirable, but their cost makes them impractical for most homes.

b. Cushions fitted to the chair seat, or seat pads, must be used for young or small-statured persons to raise student sufficiently to locate eyes correctly in relation to desk top. An 18" chair is for adults.

c. Often footstools are required too to assure relaxed posture.

4. Eye position

Must be at least 14" above desk top - for normal reading distance - and to avoid seeing the very bright inner lining of lamp shades. Eyes in normal reading position should be at approximately the distance above desk top of the lower edge of shade.

5. Position of reading material

Books should not lie flat on the desk because this horizontal position foreshortens type size. They should be propped or held slightly tilted toward the eye.

Recommended selection and placement of study lamps now on market

A pair of lamps, either wall or table type, provides more even desk illumination than single units. One exception is a single unit usually with the fluorescent tube (or tubes) which may be placed ahead of the student in such a manner that the tube is located over the center of the reading or writing material.

1. Two CIM wall lamps 30-36" apart for desks over 24" wide. $27. up, for two Pair of pin-to-wall lamps - 6" plastic bowls, 100 watts each. 6" x 6 1/2" x 9 1/2" or 10" (top diameter, vertical depth, bottom diameter), luminous (pastel) shades. Hung 15" from desk top to bottom of shade and 24" to 30" apart. Approximate price, $7.00 and up.

   Note: A table model with two extension-arms of approximate qualities and dimensions is equally satisfactory.

2. One 25" certified (CIM) table lamp - 150 watt - luminous shade - placed no more than 15" to left - or to right for left-handed student - of work center and in line with it (or as near the front edge of the desk as feasible). Approximate price, $11.00 and up.

3. One 25" table lamp with 8" or 9 3/8" plastic or blown-glass bowl, 150 watts, 10" x 10" x 18" luminous shade, placed no more than 15" to the left of desk center. Approximate price, $10.00 and up.

4. One 21" table lamp with 6" bowl (preferably plastic or blown glass) with flaring 16" shade placed no more than 12" to left of desk center (for small desks only). Approximate price, $9.00 and up.

   Many inadequately low lamps can be increased in height with wood bases and be equipped with screw-on plastic bowls and new shades. Approximate price, $2.75. A wide harp and a 150 watt indirect-light lamp bulb will change a harp-type bare-bulb lamp into an improved lamp.

5. The home craftsman may build a satisfactory lighting system for the study desk - using a 3" deep shelf on the front of which is mounted wiring channel and a 20-watt (or for long desks 25 watt, 33" or 40 watt 48") white fluorescent tube with a front shield of plastic or metal (painted white on the inner and near white on the outer side). The shelf must extend out from the wall (about 9" for 24" deep desks) sufficiently to locate the tube over the center of the reading or writing area. Approximate cost of wiring channel and lamp, $4.00 - 20-watt size. He can also build a wooden lamp like 3 or 4 above or a pair of wooden pin-to-wall lamps similar to those in 1 above.

Note: Tall statured young students and adults whose eyes, in reading or writing position, are up to 18" above the desk top may use taller lamps, of the types listed. The lower edge of the shade or shield should not then be more than 18" above the desk top.

Possibilities for remodeling existing lamps: Modernization of existing bare-bulb equipment may be possible by addition of diffusing bowls to make any of the lamps described above. While a white indirect light bulb is a little more bright than desirable for reading, a temporary improvement may be made with this bulb. It is satisfactory for casual work of short periods. Below are described two such lamps:

1. One 25" table lamp, 150-watt white indirect-light lamp bulb, slightly luminous shade, at least 10" x 10" x 14" placed as 2 and 3.

2. One wall lamp using 150-watt white indirect-light lamp bulb with pastel slightly luminous shade 7" x 7 1/2" x 11 1/2" hung 12" to left of desk center, 15" from desk top to lower edge of shade.

PERFORMANCE ANALYSIS OF AVAILABLE LIGHTING FOR READING IN BED *

Research: Research reported in 1948 describes a study of 17 typical and diversified incandescent or fluorescent luminaire installations for reading in bed.

This study is a step in getting technical data for a basic approach to lighting almost every home seeing task. Finding a solution to the problem of lighting for reading in bed is difficult, and much of the lighting equipment for this task is far from satisfactory.

Guides accepted: The guides below were determining factors in setting up research procedure:

1. Majority who read in bed are probably casual readers (20 footcandles).
2. Minority do prolonged reading with smaller type, in bed (40 footcandles).
3. Most bed readers have light close to bed and use only it when reading.
4. Luminaire should be readily accesible and easily turned off and on.
5. Readers need local lighting for reading and some lighting distributed throughout the room.
6. Other occupants are also in room sometimes at same time as bed lighting is being used.
7. The reader wants to be comfortable while reading and the location of the lamp should not interfere with a comfortable reading position nor introduce a glare source in the periphery of the visual field to distract him. It should not annoy others in the room.

Therefore, obvious essential requirements for a bed lighting installation are:

1. Adequate illumination on the reading plane -- or enough local lighting.
2. Some general room illumination.
3. Brightness of source that might be reflected by glossy paper toward the eye kept within reasonable limits.
4. Comfortable to use by reader and to other room occupants.

* A paper with the above title, written by Myrtle Fahsbender and Priscilla Presbrey, was presented at the 1948 National Technical Conference of the Illuminating Engineering Society and appeared in the December, 1948 issue of Illuminating Engineering.

Test Conditions: The test room was 12' x 9' with 8' ceiling. Workers took 5 readings on a reading plane 12" high by 14" wide, tipped 45 degrees from the vertical and with its center 33" from the floor. The plane was in an off-center location to represent a reader sitting to one side of the bed. Other readings gave brightness information and further quantity information. All readings were taken under carefully controlled conditions.

Portable lamps stood centered 8" from the wall and 30" from the center of the bed on a 28" table.

To give decorative balance, wall luminaires hung slightly higher, if large, than when smaller.

Equipment tested: The seventeen luminaires tested classify as follows:

3 bed hung: 2 spotlights (40 w inside frosted and 20 w 28 v airplane bulb) and 1 fluorescent (8 w, T-5)

5 table lamps: 2 bare bulb (60 w and 100 w), 1 opaque-shaded indirect-light bulb (150 w R 40), 2 CIM opaque-shaded lamps (50-100-150, 50-100-150 & 32 w fluorescent)

3 incandescent wall lamps: adjustable pin-to-wall (100 w), 50-100-150 CIM) lamp, illuminated wall decoration (2-60 w lumiline)

5 fluorescent wall luminaires: All used white T-12 (1 1/2" D) tubes. 15 w bare tube in adjustable reflector; 2-20 w wall bracket, open top and bottom, with curved ribbed glass shielding; 20 w and 40 w light strips under valances; and 20 w what-not shelf.

Results in quantity: Eleven of the 17 luminaires tested gave 20 footcandles, and three gave 40 footcandles. Those failing to give 20 footcandles were the low-wattage bed-hung fluorescent luminaire, 2 bare-bulb table lamps, an opaque-shaded indirect-light table lamp, and two wall-mounted fluorescents - one using a 15 w tube in an adjustable reflector and the other a 20 w tube in a valance unit.

Those producing the 40 footcandles of light needed for prolonged reading were the spotlight with a low-voltage airplane reading lamp, the CIM wall lamp and a 40 w fluorescent with a plastic and metal curved shield, open top and bottom. However, the spotlight was uncomfortable to the eyes and annoying in the room.

Results in Quality: "In general, it may be said that of the equipment tested, spotlights, units attached to the head of the bed, and table lamps with opaque shades provide a less uniform distribution over the surface of the test plane than wall-mounted units and table lamps with translucent shades," the authors state.

Units of spotlight design and portable lamps without diffusing bowls produce too much reflected source brightness or glare on the reading plane. The CIM wall lamp and the 40-watt shielded fluorescent installation are unusually good in this respect.

The opaque-shaded lamps and the decorative picture-type wall lamp contrasted a little too much with the background when lighted because of high wall brightness produced in relation to equipment. But the wall brightness was not high enough to be annoying.

Where the wall is relatively dark the brightness of the luminaire against its background was a glare source to one across the room from it. This was particularly true of the translucent-shaded bare-bulb table lamps and of a bare fluorescent tube in a reflector. In one otherwise excellent luminaire with two 20 w fluorescent tubes, the ribbed glass shield was slightly too bright.

Summary: The authors say, "On the basis of these tests, spotlight units as well as those designed to be attached to the headboard of the bed, are not satisfactory if used as the only light source in the room. The present trend toward lower headboards accentuates this conclusion. A study of the data shows that wall-mounted luminaires designed with some upward component prove to be most generally satisfactory. Table lamps with diffusing bowls carefully chosen with respect to lamp, table, and bed height, and with suitable shade dimensions and materials, also do a good lighting job."

LIGHTING FOR THE PIANO IN THE HOME *

Research: Research reported in 1949 describes work on problems of lighting at pianos for piano score, keyboard and visual field and also on placement of equipment. The purpose was to determine illumination needed for piano score and size and lighting variations of test plane, to evaluate existing equipment and to suggest new designs for piano lighting equipment. Tests reported include 15 installations: 5 floor lamps with 6 tests, 1 wall lamp, 3 rack lights, 2 reflector and projector arrangements, 1 tube reflector table lamp, a pair of experimental table lamps and an experimental tube reflector.

Testing procedures: Measurements showing quantity and quality of lighting gave a lot of information on 11 luminaires available for piano lighting and three suggested designs. Below are the test conditions:

1. Test room: 12'x 12' room with 8' 6" ceiling similar to standard IES test room.

2. Test plane: 12" high x 18" wide for score plus 9" wide on each side; 17 degree tilt. Total area: 12" high x 36" wide. 5 readings on 12" x 18" test plane and 4 more in outer corner of 12" x 36" area.

3. Visual field: wall area back of piano 6" above center of test plane and 22" to each side on walls - 3 readings; center of piano keyboard and 22" on each side of ends of keyboard - 3 readings.

4. Measuring instruments - brightness meter, data converted to footcandles.

5. Equipment tested: 2 tests with CIM senior floor lamp with circline, 3 swing arm lamps, pair of torchieres, R40 indirect-light wall lamp, fluorescent (15 w T-8) tube in reflector, rack-type fluorescent equipment (15 w T-8), reflector spot and flood light equipment and 3 new designs.

Observations: Authors determined the following through their observations:

1. Minimum and maximum readings on the score should not differ more then 4 to 1.

2. Minimum and maximum readings on area (9" wide) beyond score at each side should not be more then 5 to 1.

3. Keyboard ratio of 2 to 5 is satisfactory for visibility, but lighting should be 1 to 1/5 of test plane for eye comfort.

4. Lighting from wall has no effect on score lighting but adds to eye comfort. It should be within 5 to 1 ratio pattern.

* A paper with the above title prepared by E. W. Commery and Mary E. Webber was presented at the 1949 National Technical Conference of the Illuminating Society, and published in the June, 1950 issue of Illuminating Engineering.

5. Blonde piano finish is better then darker ones in visual pattern for eye comfort.

6. Specular reflection problems are not serious because of vertical position of score.

7. Marked decrease of light across score results with one lamp to either side, also with rack light above or below score.

Results from floor lamps: Some general conclusions resulting from the tests made are:

1. Angle and position of score present complex problems in getting satisfactory lighting from floor and table lamps. Marked decrese of light across score results with side location or closely placed rack light. A pair of floor lamps would give better lighting results then one lamp and would be desirable provided it were decoratively acceptable.

2. Swing-arm floor lamp locates conveniently and attractively and performs efficiently. Type with 100-200-300 w light bulb and large (18") luminous shade gives fairly even and adequate lighting. Opaque shade on this shorter lamp is undesirable because lighting through the shade and reflected from ceiling and wall contributes chiefly to lighting the score.

3. General purpose floor lamp in front of keyboard (3") and near shoulder gives about 20 footcandles of light, but location proves awkward and appearance unattractive. Nearer end of keyboard is too brightly lighted and distracting.

4. Totally indirect torchieres in pair and with 300 w light bulbs gave smooth distribution and 15 footcandles of light satisfactory for simpler musical scores.

Results with table lamps: Since table lamps must go on the piano, they are in line with or behind the score. Therefore, they require unattractively large or uncomfortably bright shades to illuminate the music score.

Result with wall lamps: Tests with an R40 indirect-light wall lamp and the piano at right angles to the wall gave a result classified as "only fair." This was chiefly because the shade was so bright it annoyed others in the room.

Special piano lamps: Special tubular piano lamps are not particularly in harmony with the beauty of the piano, and they are no better than conventional floor lamps in their lighting result. When mounted close to the score, the light drops off rapidly across the width of the score. When placed 7 or 8" in front of the score, a satisfactory amount of light and a comfortable brightness ratio results. However, this installation needs a lot of general lighting to balance the high level of local lighting and provide conditions for eye comfort. If the tube is long enough, the special piano lamp has the following advantages: economy in use of electricity and higher average illumination than floor lamps. A ribbed glass shield improves light spread, and generous general lighting lessens undesirable brightness of score in contrast to surroundings, but this may offset the economy mentioned earlier.

Reflector or projector bulbs: Floodlight type of reflector and projector bulbs give the smoothest lighting of any tested and enough light for all musical score reading tasks. Types of installations are:

1. Swivel-socket reflector units, ceiling mounted.

2. Semi-recessed reflector or projector light bulbs.

3. Totally recessed reflector or projector light bulbs for very low ceilings.

Reflector or projector spotlight bulbs (R30, R40, and PAR38) give a lot of light (five times as much for the 150 w size) on the test plane but less on other areas in view, with very uncomfortable results.

Ceiling installations: In addition to reflector or projector floodlight ceiling installations, there can be other types of installations in some locations.

If a piano is placed in a niche, fluorescent tubes in a soffit, shielded by thinly etched glass, can provide excellent lighting.

In a small room enough general lighting may provide plenty of comfortable lighting for piano playing, by increasing and improving lighting from floor lamps or local piano lamps.

New developments suggested: The authors suggested developing equipment specially designed to give adequate lighting at the piano:

1. Low, swing-arm lamps for on a piano, with small shades of plastic or paper (5" top D, 6" bottom D, 7" height) with 100 w deluxe white lamps. A 2" wide vertical section is in the back of shade to direct light on the score.

2. Rack-type tubular equipment using 13-watt T-5 21" fluorescent tube with white lined shield mounted on rod and possibly attached to back of piano. It should be possible to bring it to key edge.

3. A reflector or projector spotlight incandescent bulb concealed in an urn or reflector and used in combination with a tilted mirror or mirrors on ceilings to reflect light to musical score and keyboard.

Recommendations: The authors suggest as recommended footcandles for piano score:

Elementary	10 ft-c
Intermediate	20 ft-c
Advanced	40 ft-c

"The visibility of advanced scores vary over a wide range. Where notations are printed on the lines (infrequent in good publishing practice) and the entire score is substandard in size, 100 footcandles and more are needed for equivalent visibility levels to those attained above."

LIGHTING AND SEEING CONDITIONS FOR HAND SEWING IN THE HOME*

Research: Research reported in 1949, describes study of lighting conditions and equipment available to provide lighting most desirable for hand sewing in the home.

Tests reported include 16 luminaires: 5 table lamps, 6 floor lamps, 1 wall lamp, and 2 recessed ceiling installations.

Problem: About 2/3 of all American women sew at home and recognize lighting as a problem related to it. The authors learned from questionnaire answers by over 300 women:

1. Many sew in daytime because of inadequate evening lighting.

2. Room used for evening sewing largely depends on lighting.

3. At least 1/3 indicated dissatisfaction with present lighting for job.

4. Homemakers sew in almost every room, but most often in living room, dining room and bedroom.

5. Sewing includes basting, fine stitching with matching thread on flat area or on fold, weaving, embroidery, etc., on many fabrics and with different type threads.

Test conditions: Observers worked in a standard IES test room, 12'x12' with 8'6" ceiling. They chose a simple sewing task - small matching running stitches on different colors and finishes of fabric. The five materials chosen for this were a white and a gray plain, dull, finely woven, smooth cotton, similar black material in a finer weave; and a white and a black rayon satin. Matching #50 cotton threads and matching silk on the satins was used for 1/16 inch running stitches made. The seeing task was ability to see and follow a short section of these fine running stitches on the five plain materials, Measurements of the difficulty of this task under light of various quantities and qualities were made with a visibility meter. The test plane was 10x10" tilted 45° with the center 30" above the floor. Table and floor lamps gave better results when placed closer than recommended. Therefore, the table lamps centered 15" to the side and 6" back of the center of the test plane; the floor lamps centered 15" to the side and 12" back of the center of the test plane. They were 18" from the wall of the room. Eyes were 14" from the test plane.

Observers made footcandle measurements in the center and in the four corners of the 10" test square. Also they made general lighting measurements at five places in the room and brightness measurements of wall and floor, and they judged comfort and effectiveness of seeing.

Equipment tested: Nine test models of table, wall and floor lamps were certified (CIM) lamps; 2 were totally direct floor lamps with metal reflector

*A paper with the above title, written by Myrtle Fahsbender and Priscilla Presbrey, was presented at the 1949 National Technical Conference of the Illuminating Engineering Society, and published in the April 1950, issue of Illuminating Engineering.

edge 40" from the floor using 100 watt light bulbs; 2 were bare bulb table lamps with opaque shades (150 w R40 and 100 w); and two were recessed ceiling installations with flood and spot lights of different types.

Except for two CLM lamps, combining 32 w circular fluorescent with incandescent light bulbs all test luminaires were incandescent equipment. The lowest wattage rated light bulb in any of the tests was 100 watts, the highest 300 plus 32 watts.

Observations: Preliminary observations guided setting up some of the testing and lighting conditions for sewing; they were:

1. Factors helping in seeing a stitch against its background are
   Minute shadows cast by thread
   Slight ridges caused by tension of switches
   Highlights on thread - also on needle, if not too bright

2. Factors hindering seeing a stitch against its background are
   Reflections from shiny material, or
   Directional lighting on shiny materials
   Diffuse lighting on dull materials

3. Uniformity of lighting over the test plane is not so important to seeing in sewing as in reading because of the small fixed area of attention.

4. Smaller amount of light could make a task as easy to see, if properly directed, as more light less effectively directed.

5. Also, the most favorable light source location is not necessarily the same for shiny as dull fabric.

General conclusions: Some general conclusions about light for sewing from preliminary tests and observations were to get:

1. Footcandle level on work as high as practicable.

2. Some direct component to highlight stitches, thread, needle.

3. Enough general lighting to give comfortable surroundings and prevent too great brightness contrasts.

4. No sources of glare in field of view.

5. Lamps placed as close as practicable.

6. Moving of work to get most and best light.

7. Uniformity of lighting not so important except for comfort.

Quantity: A change from IES recommendations was suggested as result of tests.

Occasional sewing on light-colored fabrics (from periodic average sewing...20 ft-c)	40 ft-c
Prolonged sewing on light-to-medium fabrics (from prolonged average sewing...40 ft-c)	80 ft-c

Sewing on dark fabrics, fine detail, etc. 150 or more ft-c
(from sewing on dark goods, fine needlework...100 or more)

To make the sewing task as easy as reading 8 pt type under 10 footcandles, which is not much, it was figured that it would take for test fabrics used:

white satin	20 ft-c
white cotton	35 ft-c
gray cotton	65 ft-c
black satin	250 ft-c
black cotton	500 ft-c

Portable lamps can give 30-100 footcandles on the sewing plane. When more than this is wished, it is usually necessary to use some type of concentrating equipment, such as the reflector or projector spots and floods. These provide a high degree of uniformity of illumination on the test plane, but floodbulbs give no greater amount of light when ceiling mounted than portable lamps. Ceiling mounting was 4" behind test plane and 1 3/4" above ceiling line. The spotlights give an extra amount of lighting really worthwhile as test results show:

R40 floodlight average.....21 ft-c	R40 spotlight average..117 ft-c
PAR 38 floodlight average..48 ft-c	PAR spotlight average..200 ft-c

High source brightness of spotlights causes highlights on needle, thimble, shiny fabric, but these are in motion so the annoyance from the brightness is not too severe. Sensitivity of a person's eyes and length of time they are used determine whether or not the highlights are too uncomfortable.

When mounted locally in bridge lamps or some of the newer adjustable floor or table lamps, floodlights show excellent footcandle measurements:

75 w R30 flood in lamp.....100 ft-c
150 w R40 flood in lamp.....250 ft-c

The reflections are less likely to annoy with these instllations than with the ceiling type because of angle at which light is directed. The 75 w R30 floodlight in a photographer's swivel, which will clamp on the stem of a lamp, is a solution to getting a quantity of directional light easily. The bulb should have a shield around it, or if used bare, it should be well below eye level and aimed to avoid direct glare.

Quality of local lighting: Local lighting with some directional quality is preferable for sewing. General lighting is also needed. Research showed:

1. For most materials and fabrics, light that is at least partly directional makes for easier sewing.

2. Totally indirect light lessens highlights, reduces shadows and makes stitches look flat. It may be more comfortable with shiny fabrics. Diffuse light is good for seeing on satin; indirect light is most desirable.

3. There was some discomfort with equipment located too close; however, close location is desirable in getting a greater amount of light.

4. Adjustable height in lamps would help solve under-shade brightness problem.

Certified lamps deliver 75 to 85% of their light directly from the source onto the test plane.

Shielded or shaded R30 and R40 light bulbs near the working area give better quality lighting than ceiling installations of spot or floodlight bulbs. However, the latter are satisfactory. This is especially true of the spotlight bulbs so far as quantity is concerned.

Standard, bare inside-frosted light bulbs, in single or 2-socket table lamps having shades give reasonably good lighting for sewing. Shadows are harsher, however, than from the certified lamps or indirect-light R40 light bulb lamps.

General lighting: Few local lighting luminaires by themselves provide enough general room lighting to maintain comfortable seeing conditions for sewing.

Most all luminaires, except one or two out of 19 tested, need additional lighting to provide enough general room lighting to maintain comfortable seeing conditions.

Selection and placement: The shorter floor lamps with metal reflectors and 100 w bulbs or floor lamps using indirect-light R40 bulbs under shades, or table lamps with the same two light bulbs and all of the certified lamps give satisfactory lighting for easy sewing. Combination incandescent-fluorescent certified lamps, especially those using the 100-200-300 incandescent three-light bulb, furnish enough lighting for prolonged sewing on light to medium colored fabrics. Spotlight equipment or combination of flood or spot light bulbs with other equipment can produce enough lighting for sewing on dark fabrics, fine detail, etc. Floodlight equipment is satisfactory near working level, and spotlight equipment is better at ceiling level for quantity of lighting.

Lamps should be carefully chosen for table and chair or davenport with which used and seated height of the person using the equipment. A 25" table and an 18" chair seat put the lower edge of all the shades of lamps tested below eye level in a sewing or in a relaxed position.

LIGHTING FOR THE HOME SEWING MACHINE*

Research: Research reported in 1950 describes investigations on lighting the sewing machine. Nineteen luminaires tested included 8 shorter floor lamps, 3 medium tall certified (CIM) floor lamps, 1 swing-arm table lamp, 5 wall units and 2 ceiling units.

Purposes of tests were to determine visual task involved, lighting conditions most satisfactory for it and appraise equipment for quantity and quality of illumination they supply.

Problems: Since machine sewing is chiefly feeding fabric and guiding stitching, it is a less exacting task than most hand sewing. Eyes look at a small area around the needle. This area is about six inches square, two inches behind and 4 inches in front of the needle. The user also needs light to the left where fabric is handled and arranged. Motion is rapid. The shape of the machine causes shadows with almost any source of light.

Test conditions: The test room was a standard IES room 12'x12' with an 8'6" ceiling. The immediate test plane was the small 6"x6" area mentioned above. The secondary one or handling area, was 24x12, 18" of the length to the leftof the needle, 6" to the right. Of the 12" width, 6" was in front and 6" in back of the needle. Seven footcandle measurements were made on the smaller 6"x6" needle test area and 10 additional ones on the larger handling area. The measurements were made 30" from the floor or machine height. The test consisted of stitching a straight seam on light colored goods.

Placement of luminaires: Luminaires were placed to get most satisfactory results, considering obtaining the following:

1. Maximum illumination on area around needle (6"x6")
2. Uniformity of lighting over handling area (24"x12") area: 18" to left, 6" to right and 6" front and back of needle.
3. Minimum shadow.
4. Least bothersome location of shadows, behind and to right of presser foot.
5. Light source and high brightness surfaces out of user's view.
6. Lower edge of equipment shielding below average seated eye height, 42" from floor.
7. Shade or reflector far enough away from user's head, or lamp shaft far enough away from left arm, not to be struck when moving.

Machine lights: Machine lights come on most machines either attached front or back or under the arm. All cast deep shadows, sharp and harsh, because a small light source is used. Moving shadows are particularly

* A paper with the above title, written by Myrtle Fahsbender and Priscilla Presbrey, was presented at the 1950 National Technical Conference of the Illuminating Engineering Society, and abstracted in the September 1950 issue of Illuminating Engineering.

unpleasant. Front location of the light puts shadows back of the presser foot where they are least objectionable. Any location gives enough light around needle, but insufficient light on the handling area. Because of these faults, another local source of light is necessary. Tests were made on 19 of these supplementary units.

In some of the tests, the machine light improved the lighting from the equipment being tested; in others it cast shadows and the user preferred to sew without it.

Equipment Tested: All of the floor, table, wall and ceiling units tested had some type of shielding or reflector for improving lighting quality. Incandescent light sources were 75 and 100 w, inside frosted and 100 w or 150 w silvered bowl, 50/150 and 100/300 three-lite lamps, 75 w R30, 150 w R40 indirect light. The 100-200-300 w and 32 w war white (WW) fluorescent combined in one certified (CLM) floor lamp. The fluorescent tubes used were 2-15 w T-8 WW, 32 w T-10 WW, 18 w T-8 white semicircle, and 20 w T-12.

Quantity of light: Among the 19 units tested were luminaires which would provide 40, 80 or 150 footcandle levels recommended for hand sewing and quite adequate for machine sewing. All units tested except one 15-watt fluorescent wall unit and a 150-watt silvered bowl bulb in a shallow dome on the ceiling gave 40 footcandles of light in the handling area.

For stitching a short length of straight seam on light-colored cloth, the observers found no instance in which they felt there was too little lighting for comfortable use for a relatively short time.

Quality of light: Observations indicate that the operator can see to do machine sewing about equally well with either directional or diffuse light. While quality is not improtant for visibility, it is important for comfort for it determines the sharpness and density of shadows cast. The larger and more diffuse the light source, the softer, larger and less prominent the shadows. Directional projector lamps gave the most shadow, the highly diffuse fluorescent the least shadow, in some cases, so soft and light as to be hardly noticable.

Lamps with CLM bowls gave reasonably good results, but were still somewhat less desirable than larger fluorescent sources.

Directional light from a projector or reflector lamps is not too objectionable when placed so shadows fall behind and to the right of the presser foot. Equipment near machine must shield source from view, and overhead units must avoid casting shadow of operator's head or body on work. The overhead units tested give good lighting for occasional hand sewing.

General lighting: All equipment tested requires additional room lighting except the certified (CLM) senior floor lamp, the shallow-dome ceiling reflector, and possibly the pin-to-wall lamp with the 150 w R40 indirect light bulb.

Color, other effects: If an incandescent machine light is used, to avoid unpleasant color contrast, use one of the warmer white fluorescent tubes instead of white or cooler white.

Single-lamp fluorescent units gave no trouble with stroboscopic effect even though motion was present, nor with specular reflection from shiny fabrics.

Placement of lighting equipment: It is easy to place lighting equipment with console machines for they are narrow enough to place against a wall and still get even wall-mounted lighting units close enough. To get the same result with a machine on a bridge table it is necessary to put the machine at right angles to the wall with the presser foot near the wall. Or use a swing-arm wall luminaire or put the machine on a narrower table.

Floor lamps go to the left of the operator, or better still behind the machine.

Summary: It is possible to get reasonably satisfactory lighting for machine sewing from several types of commercially available equipment. Fluorescent types are the most satisfactory of these, and lamps with diffusing bowls are quite good. Most luminaires for supplementary local lighting of machine sewing also need general lighting to lessen uncomfortable contrasts and give extra light on the front of the machine. Equipment should be placed to avoid shadow on the area around the front of the needle also to avoid bumping it whenusing the machine or moving it around.it

AN APPRAISAL OF KITCHEN LIGHTING ELEMENTS*

Research: Research reported in 1948 describes performance of equipment available for lighting kitchens. Tests reported cover 15 ceiling fixtures, 57 arrangements for sink lighting, 2 for undercabinet lighting and 13 range lamps, all under controlled conditions.

General lighting: While general lighting is necessary, the center ceiling fixture only is not the solution. Additional local lighting is essential to give adequate seeing conditions. The center ceiling fixture causes the homemaker to work in her own shadow, and that shadow decreases the quantity of lighting on the work area. A center ceiling fixture needs an addition of either perimeter lighting or specific equipment over work areas. This added local lighting is essential under cabinets, over the sink, over the range and other work centers.

The authors say, "The unit consisting of four 20-watt fluorescent lamps, shielded," (with plastic here) "appears to be the best solution when a center ceiling fixture is required." Objections to the two 40-watt tube units are chiefly that they are too large and bulky and, in many cases, too bright for eye comfort, except for a louvered and a ribbed-glass panelled one. Metal end shields in fluorescent fixtures lessen the amount of light in certain spots in the kitchen.

The test on the common opal glass globe of medium glass and with a 150 watt inside-frosted light bulb indicated that thicker glass might be better. This would tend to reduce the shadow and lessen the excessive and uncomfortable brightness found at work areas when using it.

The indirect 150-watt silvered bowl fixture needed apparently to be larger unit to give enough light for general or local lighting. Its brightness of 830 foot-lamberts was excellent, being very comfortable to the eyes.

Sink lighting: The research shows the IES-recommended 40 footcandle level difficult to attain with present equipment. Below are some of the results from common methods:

100-watt inside-frosted light bulb in standard soffit	12 footcandles
2-20-watt fluorescents flush on ceiling	25 footcandles
2-30-watt fluorescents ceiling mounted	45 footcandles

Arrangements below give over 40 footcandles on test areas:

	24"x40"	20"x24"
2-150-watt inside-frosted in ceiling rosettes	51.6	54.1
2-60-watt inside-frosted recessed over frosted glass	89.5	93.2
1-150-watt Par-38 reflector flood over louvers	51.4	56.6
1-150-watt Par-38 reflector spot over louvers	99.0	140.6
2-150-watt silver bowl against flat white ceiling ..	46.7	49.0
2-30-watt white exposed fluorescents on flat ceiling	45.0	47.8
2-40-watt white exposed fluorescents on flat ceiling	57.0	60.5
2-40-watt white fluorescents over louvers	41.5	44.0

*A paper with the above title written by Jan Reynolds and A.W. Kakilty, was presented at the 1948 National Technical Conference of the Illuminating Engineering Society, and published in the November, 1948, issue of Illuminating Engineering.

The reflector spot over louvres gives the most light but also very high brightness directly below it when reflecting from a metal surface.

Since sink lighting fixtures are overhead and well above normal viewing angles, there is little annoyance from direct brightness. Also exposed fluorescents are usually partially shielded by valances and incandescents are recessed in soffits. Discomfort results in some arrangements because of reflection from metal utensils and sink parts which are directly in field of vision.

Under-cabinet lighting: Front edge tube placement under a cabinet gives nearly 10 footcandles more light than tubes mounted at the rear or back wall.* Exposed 20 - and 30-watt white fluorescent tubes give over 40 footcandles of light. And the 15-watt tube gives nearly that much. With general lighting any of these fluorescent tubes mounted at the front under the cabinet gives enough light, and front placement insures uniformity of lighting coverage over work areas.

Range lighting: Additional or supplementary lighting above the range is necessary to provide good seeing conditions here. This may be on the ceiling, under soffits or below cabinets above the range. The range lamp is helpful in providing some lighting, but its low placement in common range design results in:

Considerable variation in amount of light on top of range
Highest footcandle readings under lamps at back of range
Lowest footcandle readings at front of range
Practically no light inside pots, kettles and deep-well cookers.
Distracting or uncomfortably bright reflections from metal and porcelain

After checking 13 range lamps in complete darkness, the authors concluded that "it is doubtful if a completely satisfactory means of range illumination can be accomplished only on the range itself." These lamps included fluorescent and incandescent and shielded and unshielded equipment.

Since publication of this research, range designers have apparently heeded the authors' suggestion to give more attention to performance of task rather than designing range lamps chiefly for decoration and appearance. Higher backsplashes, full-width range fluorescent and even adjustable height lamps are trends in this direction. However, a close study of the results of under-cabinet lighting research reported above shows that the back placing in itself results in a loss that is hard to overcome with present range lamp design.

BHNHE U-SHAPED BUILT-IN FLUORESCENT EQUIPMENT

An eye-saving built-in fixture came out of research on a step-saving kitchen. In developing its U-Shaped kitchen, specialists in the Bureau of Human Nutrition and Home Economics devised an eye-saving, built-in U-shaped ceiling lighting fixture. The artificial light is semi-indirect, and illuminates work surfaces with minimum glare and shadow. The fixture is a U-shaped wooden trough with four 40-watt fluorescent tubular bulbs mounted on it. Working drawings for this fixture are available from the Extension Service in many States.

LAUNDRY LIGHTING REQUIREMENTS*

Research: Research reported in 1949 describes some preliminary work on laundry lighting.

Test conditions: An existing laundry in Blanding's Dream House, Pittsburgh, measuring 15'x8' with a 7'5" ceiling served as the test room.

Measurements were made with three arrangements of lighting equipment: the existing centered straight-line fluorescent installation (3 units with 3 40-watt tubes each); four bare light bulbs - one in each corner; and four 2-tube fluorescent louver-shielded fixtures - one in each corner.

Observations: In the above installations, only the lengthwise, centered, 9-tube fluorescent one gave as much light on work centers as the average for the room.

The lighting at an occupied work center varies a lot from what it is in an unoccupied room. In averaging all of the centers in the laundry tested, this loss when a person worked in the work center amounted to a loss of slightly over half of the lighting when the room was unoccupied. And this figure was probably better than normal because of the cleanliness, light color of the room, the highly diffusing lighting equipment and the number and spread of the units used.

Apparently the type and quality of lighting equipment and light sources, and their color characteristics affect greatly the seeing of certain objects.

Conclusions: The preliminary study of lighting in the laundry or utility room indicates:

1. Wall and ceilings should be light-colored to reflect light back on equipment.
2. With low ceilings of most laundries, equipment should be close-mounted ceiling equipment, or, if possible, sometimes wall brackets.
3. Lighting should be well-diffused to avoid harsh shadows of the user of the equipment. Under some local conditions, wall-mounted equipment should be used.
4. Standard layout is desirable for attractive appearance but often brings light on wrong side of operator.
5. A good minimum amount for general lighting would be 10 footcandles
6. A higher level is needed at close-seeing centers, for work such as reading dials and ironing.
7. Among special tasks requiring more light are painstaking ironing, which might require a minimum of 40 footcandles over the whole ironing plane.

* A paper of the above title, written by A. W. Kakilty, was presented at the 1949 National Technical Conference of the Illuminating Engineering Society, and published in November 1949 issue of Illuminating Engineering.

8. Further study is needed to get information on desirability of recommending definite color characteristics for lamps located over ironing centers.

Some later research in a commercial laboratory by Arthur A. Eastman, reported in the January 1950 issue of Illuminating Engineering bears on color characteristics of light bulbs or tubes as related to visibility of scorch marks. Mr. Eastman's research determined that with equal lighting, visibility was practically the same with daylight fluorescent as with daylight incandescent. Also, with other lamps, it decreased somewhat with a decrease in blueness.

AN EVALUATION OF METHODS AND FIXTURES USED FOR BATHROOM MIRROR LIGHTING *

Research: Research reported in 1947 describes a study to evaluate lighting effects in using the mirror for shaving. Tests reported cover 13 diversified installations, fluorescent and incandescent, shaded and unshaded, in a total of 23 different fixture combinations and placements and also at several mounting heights, all under carefully controlled conditions.

Research on bathroom mirror lighting came as a first step in getting a more technical basis behind recommendations for every lighting use in the home. The homemaker is becoming aware that the basic purpose of fixtures and lamps is to provide lighting for home seeing tasks and that this is a greater factor than aesthetics in selection of lighting equipment. Increased knowledge by lighting consultants and public demands more research on lighting various activities. The bathroom mirror is an all-purpose looking glass which serves all family members in many critical seeing tasks.

Testing bathroom mirror lighting: The basic test point was 61 inches above the floor and 20 inches away from a mirror around which the fixtures were installed. Research workers took readings at the following positions with a lightmeter:

Normal to the mirror and representing a full face view
45 degrees from the normal line and representing the left cheek
45 degrees from the normal line and representing the right cheek
Under chin

They averaged left and right cheek readings to get the side face figure. They also checked the brightness of the glassware instrumentally and evaluated it for eye comfort. The test room was 6' x 6' with an 8' ceiling, the upper half painted white, the lower part tiled.

Under-chin lighting problems: Problems encountered in getting enough light under the chin for shaving were:

Shadows under chin from lighting in over-mirror fixture placement.
Uncomfortable brightness from over-mirror fixture with raised head.
Shadows from hands and shaving equipment.
Shadows under chin from lighting in high placement of side brackets.
High brightness of sunlamp with head raised for under-chin shaving.

Findings on mirror lighting: There was some shielding of light sources in 11 cases out of 13 installations tested, all except a lumiline incandescent and one fluorescent installation. The two bare tube lumiline side brackets were too bright, and their rating was "fair minus." The pair of exposed fluorescent tubes in side brackets, rated "good," were larger diameter, 15-watt T-12 tubes.

* A paper with the above title, written by Myrtle Fahsbender and Beryle Priest, was presented at the 1947 National Technical Conference of the Illuminating Engineering Society, and published in the December, 1947 issue of Illuminating Engineering.

While their glare was not excessive, the report stated that "shielding will increase comfort by reducing brightness," and "with comparatively little loss of footcandles." The over-mirror incandescent fixture having an open bottom opal glass reflector rated "poor," and RS Sunlamps in metal reflectors were uncomfortable to some. The brightness and deep shadows from the sunlamp installation did not bother others.

Ceiling lighting: The only ceiling installation tested was a two unit one, each with a recessed 100-watt incandescent light bulb shielded with stippled glass lens. This installation in the ceiling above the mirror gave harsh brightness and deep shadows, therefore unsuitable lighting for the mirror.

Over-mirror lighting: When the budget permits only one outlet for lighting, an over-mirror, two-tube, shielded fluorescent bracket is preferable to incandescent types. Over-mirror lighting results in shadows under the chin and often eye discomfort when the head is raised for shaving. However, one fixture tested gave good enough lighting to rate "fair plus." It was a fluorescent open-top bracket with enameled interior reflecting surface and a ceramic treated curved glass shield, using two 15-watt small diameter (T-8, 1-inch) tubes. Two 20-watt tubes are probably preferable, according to the report.

The exposed incandescent light bulb in an open-bottom reflector or the clear glass lens in some two-bulb, incandescent, over-mirror brackets are bright enough to be annoying while shaving. Turning over the glassware of the opal glass reflector gives less light but greater comfort. Both types tested with 60-watt bulbs gave only 4-6 footcandles of lighting under the chin. And the two 100-watt incandescent ceiling recessed, glass shielded fixtures tested gave only 7 footcandles under the chin. All produced harsher shadows and more glare than other types.

Light sources used in over-mirror lighting brackets were 60-watt inside-frosted incandescent light bulbs singly or in pairs, 15-watt T-8 3500 degree white fluorescent tubes in pairs and the 275-watt RS Sunlamp with 2-60 watt light bulbs. Best mounting height for sunlamps is 18 to 24" above the forehead.

Side-mirror lighting: Most shielded incandescent and fluorescent side brackets got a "fair" to "good" rating when installed at a mounting of 5'6" and gave more lighting under the chin of the shaver when mounted at 5'1" or 5'2".

A person 61" to the center of his cheek will have more illumination on his face and under his chin if the mounting height is 5'1" - 5'2", according to the tests.

Sources of light tested were 60-watt inside frosted incandescent bulbs in single socket brackets, 40-watt bulbs in two-socket brackets, 60-watt T-8 white lumiline, and 15-watt T-12 3500 degree white fluorescent tubes.

Shielding is necessary for ordinary bulbs and lumiline tubes and desirable for fluorescent tubes.

The glass brightness with two 40-watt inside frosted bulbs while not excessive was still too bright for comfort.

Fluorescent tubes unshielded were rated "good" and shielded "good plus." With exposed fluorescent tubes it is advisable to use larger diameter rather than smaller diameter tubes to get lower brightness and greater comfort.

Combination over-and-side mirror lighting: A test on a three-bracket installation shows it provides high levels of lighting but the glassware brightness was too great for comfort. The fixture above was an incandescent (2 60-watt) type with clear glass lens and the side brackets were open-top glass globes with 60-watt inside frosted bulbs. It is thought that with carefully chosen low-brightness glassware and side brackets at lower mounting height, this three bracket combination would give acceptable lighting.

Around-face lighting: A circular fluorescent tube in a shielded fixture using a white or light pink reflector around a circular mirror has certain advantages:

Low brightness
More even distribution around face
High under-chin lighting

The fixture is unsatisfactory in use to a person wearing glasses. It might be a more desirable fixture with a wider reflector than that tested.

Mirror lighting for general illumination: From tests in the 36 square foot bathroom under nearly ideal conditions, the authors decided that "there are not many mirror lighting bracket arrangements which will maintain the five footcandles general illumination" currently recommended. With high reflectance walls and good maintenance, some will probably maintain 5 footcandles in a 45 square foot or smaller bathroom but probably not in suggested areas of under 60 square feet. The circular fluorescent fixture good for local lighting falls short in providing general lighting for the small test bathroom. However, it makes an excellent additional mirror in the bathroom for use in shaving or make-up; and it may give all of the light needed in a small powder room.

Summary: "Two brackets, one on each side of a bathroom mirror, contribute more acceptable lighting for either shaving or make-up, than a bracket placed over the mirror," the authors affirm by their research.

A mounting height of 5'1" to 5'2" from the floor gives higher lighting levels under the chin than recommended higher mounting heights. These lower mounting heights are particularly recommended for single lamp incandescent brackets and desirable for tubular brackets.

Satisfying the lighting needs for shaving will in nearly all cases provide adequate conditions for make-up or other purposes. However, in shaving it is not possible to eliminate all shadow effect.

To maintain satisfactory general lighting, a central ceiling fixture should be provided in all bathrooms regardless of size, except powder rooms. Wall brackets should be used as supplementary units for lighting those seeing tasks related to the mirror to which they are adjacent.

School Lighting

Community responsibility: Your responsibility is only partly taken care of when your home is well lighted. It is up to you to see that your schools are well lighted. The children who attend are your children or your neighbors' children.

A child's business is going to school, and good seeing helps him to be successful in this business. Children do their best work and behave best under good lighting.

Problems: Light for school work should come from the left and from above. All children in the room should have good lighting, not just those near the windows. Footcandle recordings in different parts of the room should be taken over a period of several days. Children near the window have been found to have as much as 90 footcandles of light while those farther back in the room often have only 5 footcandles.

The school should take every possible advantage of the daylight by having two-roller shades or some arrangement so that the light in the upper part of the window can be adjusted separately from that in the lower part. A great deal of information is available regarding the size bulbs and type of equipment that should be used for different sized rooms. Trained lighting people can get this for your school board. There are also bulletins available through the State Superintendent of Schools.

Incandescent bulbs used in school room lighting are very large ones. Small rooms require not less than four fixtures and most rooms need at least six or more. The fixtures may be either of the indirect or semi-indirect or semi-direct type. The semi-direct glass enclosing globe type of fixture is also used though not so commonly as in the past. There are many louvered semi-direct fluorescent fixtures and suspended semi-indirect plastic troughs for fluorescent tubes in modern schools.

Lighting rural schools: For good school lighting there must be a proper balance of natural and artificial light. (Proper fenestration and lighting devices, fixed and portable; color and finish of walls, floors and ceilings). Minimum standards for good school lighting are:

1. 30 foot-candles of light on every schoolroom and school lunch kitchen working surface.
2. 40 foot-candles for drawing, typing, sewing and sight-saving rooms.
3. A rough-rule of thumb guide to light proper surface and furniture finishes is: 6 foot-candles on the desks for each watt per square foot from a good incandescent installation, or 15 foot-candles for each watt per square foot from a good fluorescent installation. Thus, in a properly finished 24' x 36' schoolroom, about 20 foot-candles of artificial illumination may be expected from six 500 watt, silvered bowl, concentric ring, incandescent units or 30 properly shielded 40-watt fluorescent tubes arranged in units or strips. If the fenestration is designed for a minimum of 10 foot-candles from natural sources, either of the foregoing installations should result in a minimum of 30 foot-candles from combined natural and artificial sources.

Value of cleanliness: School lighting equipment should be kept clean. The fact that school lighting equipment is not kept clean accounts somewhat for the high lighting recommendations of 40 or 50 footcandles which are made by some lighting authorities. Some authorities also say that 12 to 20 footcandles of light is the minimum requirement for each student.

Most sources place it higher. It is desirable to have 30 footcandles of light. Even more might be used to advantage especially in laboratories and study rooms requiring more close work. An automatic system has been installed in many school rooms. Lights are automatically turned on when the amount of light drops below a certain point.

An REA-financed cooperative can lend the schools in its area a light meter and give the teachers much information on classroom lighting.

Community Lighting

Importance: Community buildings and offices of the community's educational leaders should be examples of good lighting to members of the community. Community center lighting improvement programs will result from the cooperative efforts of county superintendents of schools, farm organization leaders, managers of local power supply systems and committees of interested community members.

Community buildings: Committees of local leaders can see that lighting in community buildings is improved. The first step is to shield any bare bulbs, using large fixtures for comfort.

Special lighting for close seeing should be provided at work areas in community buildings.

Good desk lamps: Many rural people belong not only to REA cooperatives but also to other farm organizations. They can do a real service to all farm people in the community by encouraging cooperative managers, county farm and home agents and teachers in all school systems to use certified (CIM) study lamps on their desks, if they are not already using them.

The most effective way to do this is for the local power supplier to arrange for constructing homemade lamps or locate an attractive certified study lamp at a reasonable cost. Most community educational leaders will cooperate in helping to explain the importance of people having good reading lamps and illustrating the best types by having examples of them in places where many farm people will see them.

Church Lighting

Worship area: Lighting a rural church calls for equipment that will deliver enough comfortable lighting and still maintain the atmosphere associated with a church. In the area where church services are held the effect is gained chiefly by having fixtures that suit the architecture of the interior and remind worshippers of a church setting. Enough light is needed for older people to read church music and service programs.

Many of the newer church fixtures have diffusing bowls built into the interior of a conventional church fixture. Some use floodlights inside of their fixtures. Floodlighting or spotlighting equipment can furnish light for special areas such as the pulpit. Cove lighting furnishes ceiling lighting in more expensive installations. Care in choice of pulpit and organ reading light is necessary to prevent bringing a glare source into worshippers' line of view.

Other church rooms: In church basements, recreation areas and other places where services of worship are not held, good quality utilitarian lighting equipment is needed. This may resemble that used in other community centers and schools, though the amount of lighting need not be quite as high as that for critical eye work in schools.

Planning church lighting: Distributors of lighting equipment or local lighting engineers of large lamp manufacturers can usually furnish catalogs of church lighting equipment from which choices can be made within the budget for this purpose. REA can also furnish some sources of church lighting information.

References:

1. Lighting Schoolrooms, Pamphlet No. 104, Federal Security Agency, U. S. Office of Education, Washington, D. C.
2. Sixteen Ways of Daylighting Classrooms, Haskell, Architectural Record, May 1, 1944.
3. American Standard Practice of School Lighting; Daylighting Recommended Practice (1950) - Illuminating Engineering Society and American Institute of Architects, 51 Madison Avenue, New York, N.Y.
4. Guide for Planning School Plants, National Council on School Construction, Part II of the 1946 proceedings, pages 58-73.

Ft-c*	Community Centers - Area or Activity to be Lighted
5	Hospital corridors. Recreational croquet, horseshoes, skating.
10	Auditorium used for assembly only, dining area, library stack room, lockers and shower rooms, office lobbies and reception rooms, Recreational basketball, handball, golf, hockey, soccer, softball, tennis, volleyball, swimming pools.
20	Church pulpit, speaker's rostrum, club lounge and reading rooms, kitchen, gymnasium for general exercising, Sunday School rooms, vaults.
30	Conference rooms for general meetings, general laboratory work, library reading room, class and study rooms, gymnasium for exhibition games, office filing, mail sorting, intermittent reading or writing, writing room.
50	Close laboratory work, sewing room, general lighting for hospital operating room, food displays, prolonged close office work (bookkeeping, typing, stenographic work, reading blue prints).
100	Close inspection, sewing on dark goods, very fine and prolonged work.
200	Operating table, minor operations, major operations need up to 1,000 ft-c.

* Footcandle recommendations adapted from IES Lighting Handbook, 1947.

Equipment Available

Various types of lighting equipment are available for improving poor lighting:

Bulbs	Application or Place of Use
Silvered bowl	Direct light fixtures, bridge lamps
Silica or ceramic white	Thin glassware, bare-bulb lamps
White indirect-light R-40	Portable lamps of bare-bulb type
Cream-bowl (mushroom shaped)	Bare-bulb ceiling fixtures
Flared-top diffusing bowls	
4" candle diffuser, plastic	Bare-bulb candles in floor lamps
6" bowl, glass or plastic	Wall lamps and table lamps under 20"
8" bowl, glass or plastic	Table lamps over 20"
9 3/8" bowl, glass or plastic	Table lamps over 20", short floor lamps
10" glass bowl	Floor lamps
Shades	
Candle shades	Bracket and cluster fixtures
Shades of various sizes	Fixtures, portable lamps
10", 12" or 14"	Lamps under 20"
14", 16" or 18"	Lamps over 20" (18" shade over 28")
Plates	
Adaptor plate	Flat metal plate for bridge lamps
Wall-lamp plate	Flat ventilated metal plate with center hole for low-hung wall lamp with 6" diffusing bowl
Lamp converters	
Kerosene converters, #1, 2, 3	Change fuel lamps to electric ones
Vase converters--cork, etc.	Make lamps from vases, bottles
Candle converters--rubber, etc.	Make lamps from candlesticks
Converters for wood mounting	Make wooden lamps
Shade holders for bowls	Hold flared-bowl diffusers
Lamp adaptor conversion unit	Includes bowl, husk, cord and plug for floor and table lamps
Miscellaneous harps	For white indirect-light R-40 bulbs
Wide harps	For various types of shade fitters
Shade converters	For making shade into clip-on type
Clip-on fitters or clamps	
Fluorescent tube shields	
Clip-on plastic	Single tube unit
Slip-over plastic	Single tube--clear, white, colors
Clip-on metal louver--20", 40"	White rounded louver of thin metal
Metal valance; wooden valance	Bed or study lights; window valances
Homemade plastic sheet	Any shape, size or number of tubes
Glass shield in soffits	Soffit above shiny metal sink
Various types--glass, etc.	Basic units--different shields

Incandescent bulb shields	Application or Place of Use
Adaptor--reflector type	Laundry, work area fixture
Adaptor--globe	Kitchen or laundry fixture
Clip-on shields--plastic	Bare bulb on drop cord, rosette
Clip-on shields--paper	Bare bulb on drop cord, rosette
4" plastic fixture bowl	Bare-bulb ceiling fixture
6" plastic fixture bowl	Single-bulb ceiling fixture; also for pendant bracket, wall or bridge lamp; fits under special shade to hold bowl

Improving Types of Lighting

When you have uncomfortable lighting of the following types, consider trying some of the following methods of improvement:

Direct light	Placing louvers or shields below; using silvered-bowl, cream-bowl, white silica or ceramic or white indirect-light R-40 bulbs; painting background white or light gray; using dull or mat finishes
Semi-direct	Converting equipment to give another type of lighting; painting background lighter
General diffuse	Using white silica or ceramic bulbs or smaller size bulbs; painting background lighter; substituting thicker and larger shielding
Semi-indirect	Using white silica or ceramic bulbs or smaller bulbs; painting background lighter; painting etched patterns
Indirect	Adding more lighting from below; changing hanging height; using lower wattage light bulbs; changing color or value of background

Two general methods of improving lighting are: remove light source from line of vision by raising or lowering or by shielding; reduce brightness of equipment or increase that of surroundings.

Getting rid of glare, shadow: Glare may waste one half of the light by making it not usable. Below are a number of methods of getting rid of glare and also in many cases objectionable shadows:

Move light source farther away or to one side
Raise light source out of line of view
Move pictures or mirrors which reflect glare
Use dull paints and varnishes, rough-textured wallpaper
Increase general lighting in room; lighten room colors
Use diffusing bowls or indirect-light bulbs in lamps
Buy lamps with shades thick and deep enough to shield source
Use a larger diffusing bowl or fixture or put a white bulb or smaller bulb inside a too-bright bowl
Put a white paper lining in a thin shade or
Paint, use shoe polish, or have inside of shade sprayed in auto repair shop--use dull white paint
Sew in another inner liner in a too-thin fabric shade
Increase intensity of light in surrounding area
Remove bare bulbs at eye level, or shade them
Lighten colors in area surrounding eye task
Paint etched designs on fixtures with white paint
Avoid sharp contrasts of light and color

In order to avoid sharp contrasts which tend to attract attention to the light and away from the work:

Choose large equipment to provide large light source
Turn several lights on in room to balance lighting
or place lamp near corner and face wall
Or use ceiling fixture with portable lamp or lamps
Have light sent upward to ceiling, then diffused
from there back into room
Use translucent shades against light walls
Use darker, opaque shades against dark walls
Draw window shades when working near windows at
night to decrease contrast and light loss
Place equipment carefully or add light to
avoid shadow on work or sharp contrast

Improving fixtures and lamps

These topics are covered in detail under separate sections on fixtures and lamps. Some of the methods of improving include:

Changing parts or adding parts
Painting equipment--lamp bases, stems, fixture body
Buffing, replating or refinishing equipment
Turning parts or glassware--in bridge lamps or brackets
Cutting down equipment or rehanging at different height
Changing length of stems on tall floor or
table lamps and fixtures with metal saw
Raising short lamps on bases
Rearranging table lamps on different tables

Daylighting

The effect of window treatment or condition on lighting during the day may be great as table below shows:

Window treatment or condition	Loss of light
Dirt on window glass	15-25%
Fly screen over whole window	50%
Fly screen over lower half of window	15%
Painted fly screen over whole window	60%
Painted fly screen over half of window	20%
Upper half of window shaded	60%
Upper fifth of window shaded	15%
Curtains and draperies	75%

Some points in making good use of daylighting in home are given below:

Home window treatment for best use of daylight
Have window area equal to $\frac{1}{4}$ floor area
Use glass blocks in construction (may produce glare)
Use bronze or copper screens on lower $\frac{1}{2}$ of window
Keep window glass and screens clean
Use translucent window shades

Draw roller shade 1/5 from top or less
Use thin light-colored curtain material
Put draperies beyond window edge, or add windows
Avoid deep valances of heavy dark material

Summary check list: Below is a check list for improving lighting in the home. Look at your equipment with these points in mind.

Change bulb size
Change bulb type
Shade bare bulbs
Shield bare bulbs
Add extra light at work
Buy adaptors
Replace dark shades
Use white shade linings
Raise short lamps on stands
Turn equipment parts
Add extra light at work

Increase general lighting
Make rooms lighter
Clean walls, ceilings
Clean bulbs, equipment
  Dust every 2 weeks
  Wash every 2 months
  Use soap twice yearly
Raise or lower light source
Get more light closer to work
Move work to improve lighting
Make work background light

CHOICE, USE AND CARE OF LIGHT BULBS AND TUBES

Terms, Life, Specifications

Terminology: Though the source of light commonly used for electric lighting is traditionally called a lamp, it is commonly called a "light bulb" or a "lamp bulb," or sometimes, as in the case of fluorescent sources, a fluorescent tube.

There is considerable merit, however, in calling the source of light a light bulb or a tube, instead of a lamp. The word, "lamp," is also used to designate the portable floor, table and wall lamps. In recent years, most commercial companies are using the more common terminology of light bulb in their consumer literature. Technically bulb and tube refer to the glass part of light bulbs and tubes.

Inspection of light bulbs and tubes: Great care and precision in manufacturing produce today's high quality light bulbs and tubes. Manufacurers carefully inspect the parts going into these sources of light as well as the finished bulbs and tubes. Research constantly carried on by large manufacturers improves the efficiency and lowers the cost of light bulbs and tubes.

Standards and specifications: The American Standards Association, New York City, has set up standards for nearly every type of incandescent light bulb and fluorescent tube.

The specifications set up by the Federal Government are available from the Superintendent of Documents, Washington 25, D. C. The National Bureau of Standards, the Bureau of Federal Supply, General Services Administration and various branches of the Department of Defense are agencies of the Federal Government that develop such specifications. These guide both manufacturers and Government purchasing departments and give consumers some valuable information.

Rated average life in hours: Below are listed some manufacturers' figures on average rated life in hours for various electric light sources.

Type of Bulb or Tube	Life in Hours
Fluorescent (hot cathode)	4,000-7,500
General incandescent	750-1,000
Floods and spots (R & PAR)	1,000
Floodlight (not reflector floods)	800
Spotlight (not reflector spots)	200
Projection	10-50
Photoflood	2-10

The "burning" life of the fluorescent tube is rapidly increasing. Formerly around 1,500 to 2,500 hours, it now is enough higher that manufacturers stamp some tubes 4,000 hours and claim figures as high as 7,500 hours of burning life for general use tubes and up to 10,000 hours for slimline tubes. Fluorescent tube life depends somewhat on the number of starts, as more frequent starting tends to decrease length of service. Figures

are usually given on the basis of average life at three hours per start. This means the tube is used an average of three hours for each time it is turned on. Home use might mean shorter periods per start and might cause tubes to last a shorter length of time than the rated life. A figure of 3,000 hours is probably conservative for 1-hour average burning per start, with new tubes having improved cathodes and cathode coatings.

Types of bulbs available: Many types of light bulbs and tubes are available. This section deals only with light bulbs and tubes more commonly used in the home and on the farm.

Types of Incandescent Light Bulbs

Parts of light bulb: A light bulb is made up of a base, the filament, or filaments, the glass bulb and a vacuum or gas such as argon or nitrogen or in some krypton. The base is of metal with contact points to the socket. The filament or filaments consist of coiled or coiled-coil tungsten wire. The glass bulbs come in various shapes and diameters.

Shapes of Incandescent Bulbs Commonly Available

A	(standard line)	Common type--25, 40, 60, 75, 100, 150 w
PS	(pear shape)	Higher wattage--200 w and up
G	(globular or round)	3-light; small decorative bulbs
GA	(globular & standard)	Mushroom shaped cream bowl
C	(cone-shaped)	7 w candelabra
F	(flame-shaped)	15-25 w decorative bulb
S	(straight-sided)	10 w, other low-wattage bulbs
T	(tubular)	Lumiline, show-case reflector, small tube
R	(reflector)	Spot or flood bulbs
PAR	(parabolic aluminized reflector)	Pressed glass projector bulbs of spot or flood type for indoor or outdoor use

Diameter is measured in eighths of an inch, thus an R-40 bulb is a reflector type 40/8 or 5 inches across.

Manufacturers make bulbs of a special heat-resisting glass for use out-of-doors or where there is danger of splashing with liquids. These bulbs are available in projector shaped (flattened at end) and ordinary shaped weather-proof light bulbs.

Bulb finishes and colors: Below are common bulb finishes and colors, and their uses in the home.

Finish and Color	Use of Bulbs
Indirect-light	Used in standard base 75-125-200 w R-40; 100, 150, 200 & 50-100-150 w R-40. Mogul base 100-200-300 w, R-40 & G
Inside-frosted	Used in lamps 15-200 w; 30-70-100 & 50-100-150 standard; 100-200-300 Mogul; little loss of light; quality better, preferable to clear glass bulb
White (silica or ceramic)	60 & 100 w size used in thin glassware fixtures, Mogul 100-200-300 w globular. Also 6-300, 40-60-100; 50-100-150 medium & 300 Mogul. Outside-coated white bulbs in small sizes 7-40 w

Finish and Color	Use of Bulbs
Metallic reflector coating	75 w R-30, 150 w R-40, 200 w, 300 w R-40, 75 and 150 w PAR 38
Cream bowl	Used to improve bare-bulb fixtures, 50 w, mushroom shaped
White bowl	In higher wattage types; used in thin globes and open-mouth reflectors to reduce glare; creamy white, translucent finish on bowl of bulb; chiefly industrial
Silvered bowl	Metallic finish on bowl of inside frosted lamp; used in indirect lighting fixtures and modernization of equipment. 60, 100, 150, 200 w common.
Daylight blue	Good for color discrimination. 20, 40, 60, 100, 150, 200, 300 w. Hardly ever used in homes.
Insect repellent	Yellow bulb for repelling insects. 6-200 w.
Colored lamps	Inside or outside colored, enameled, or natural colored. Decorative; in flame, globe and tubular types.

Ordinary household bulbs: The most common type of light bulb used in the home is the inside-frosted, incandescent, one-filament or single wattage one. Common sizes with standard bases for household use are: 200, 150, 100, 75, 60, 50, 40, 25, and 15 watts. Larger sizes are sometimes used, such as 300 watt. Night lights with 10, 7½, 7, 3 and 1 watt bulbs are used in homes, but some of these have smaller bases.

Suggested Use of One-Filament Incandescent Light Bulbs:

200	In indirect ceiling fixtures in kitchen, library or any room using large indirect fixtures.
150	Kitchen, laundry, dining room and living room ceiling fixtures. Widely used in reading lamps.
100	Bedroom, large bathrooms, small kitchens, breakfast nook and other ceiling fixtures. Also in wall lamps.
75	Bathroom and hall ceiling fixtures, wall lamps.
60	On porches and stairs, in halls and closets, in bracket fixtures in kitchen and bath, in dresser lamps, in multiple-bowl or cluster fixtures in living and dining room.
40	In 5-lamp cluster fixtures, in small brackets, in small areas everywhere 60's are used.
25	Decorative lights; in thin-glass cluster bowl or bracket.
1-15	Used as night lights in bedroom, bathroom, hall.

Three-light or two-filament bulb: A second type of bulb being used in homes is the three-light or two-filament bulb. It has two filaments of different wattage. You can adjust the light easily for the difficulty of the task being done. A three-light bulb has a special three-contact base which fits into a special socket. This bulb gives any of three different amounts of light when used in a socket with a three-position switch. Or it gives two different amounts of light (highest and lowest of marked wattages) when used with a socket controlled by a two-position switch.

With the three-position switch, you can turn on the two filaments together, or either the larger or smaller filament alone. The two-position switch turns on the filament using less wattage, or both filaments together for highest wattage. Three-light bulbs come with Mogul or large bases, or with medium or standard bases. Three-light medium base bulbs come in 50-100-150 w, 40-60-100 w and 30-70-100 w sizes. Light bulbs with large Mogul bases fit in special large Mogul sockets found in some floor and table lamps and dining room fixtures. The most common Mogul-base bulb used in the home is the 100-200-300 watt size. Another size 50-100-150 with Mogul base is less commonly available now. The medium-base three-light bulbs replace it. There are screw-in converters to change Mogul sockets to medium, and there are converters to make medium sockets Mogul. Suggested uses of two-filament bulbs are listed below:

100-200-300 and 50-100-150 w (Mogul base) in floor and table lamps and in some dining area fixtures.

50-100-150 (medium base) table lamps, some 56" floor lamps, pin-to-wall lamps.

30-70-100 (medium base) or 40-60-100 (medium base) pin-to-wall and dresser lamps, brackets.

Three-light bulbs are either globular or round, or projector or reflector bulb shaped.

White indirect-light bulbs: Since the war, reflector shaped light bulbs with heavy inside coating or whitening are coming into wide use for home lighting. These white indirect-light bulbs substitute for a bowl and light bulb in table and floor lamps and improve bridge lamps and some large single-bulb fixtures with thin glassware.

Two sizes are available, the R-40 (5" D) and the G-30 (3 3/4" D). The R-40 comes with one-filament (150 w) or two filaments (50-100-150 w or 75-125-200 w). G-30 is a 100-200-300 w two-filament light bulb with a Mogul base. There is also a three-light Mogul base R-40 indirect-light bulb in 100-200-300 w size. The source brightness of the larger reflector-shaped white indirect-light R-40 bulb is too high to make it comfortable for prolonged close reading or other close eye work except sewing on dull material.

Silvered-bowl and white-bowl light bulbs: Silvered-bowl and white-bowl light bulbs have a "built-in" feature in the form of a bulb finish to direct the light. The silvered-bowl bulb when used base up simulates indirect light, and the white-bowl bulb, semi-indirect light. Both finishes help to direct light upward, when used base upward.

The silvered-bowl bulb gets first a silver dip, then a copper electro-plate and last a coat of aluminum paint sprayed and then baked on the outside of the bulb.

The coating of silver on the bowl of the glass bulb makes it like a mirror on the inside. The light from the filament cannot go through the bottom of the bulb but is instead reflected upward to the ceiling, or in a lamp to the shade around it. It gives a more pleasing light and a light which is easier on the eyes than a bare bulb in the same location. While usually

used base up, it finds use in base down position in a floor lamp with metal reflector designed especially for it.

A silvered-bowl bulb helps to modernize an old bridge lamp which has a bare bulb. Also you can put one or more low-wattage, silvered-bowl bulbs in a bare-bulb fixture in low-ceilinged main rooms. Or use a higher wattage one in standard RLM or other direct-light reflectors in the laundry or work shop. The silvered-bowl bulb forms a part of a certain type of fixture, the silvered part of the bulb showing in the center of the fixture. The rest of the fixture is made of parchment, plastic or metal. These fixtures are also especially good in rooms with low ceilings. Silvered-bowl adaptors are available to modernize poor lighting installations. You screw an adaptor into a socket just as you would a light bulb.

Daylight light bulbs: Daylight bulbs are made of a special blue glass, which absorbs the red and yellow rays from the filament and supplies a light more nearly like daylight. These bulbs are excellent for use in certain locations in kitchen, laundry and sewing rooms. However, the blue glass absorbs about 35 percent of the light.

The whiter light from daylight bulbs is good for color matching and also in the laundry area for detecting dirt, scorch, stain and running of colors. It will also help you to judge how your make-up will look in daylight if you use the daylight bulbs at your mirror in the bathroom.

Daylight bulbs for home use come in the 60, 100 and 150 watt sizes, also in 25, 40, 200, 300 watt and larger size. Since blue glass absorbs about 1/3 of the light, it takes a larger size bulb to give the same amount of light as that from an inside-frosted incandescent bulb. In replacing an inside-frosted bulb with a daylight one, use the next higher wattage. For example use a 150-watt daylight for a 100-watt location.

Weather-proof bulbs: Hard glass bulbs of ordinary shape come in wattage sizes of 50, 75, 100, 150, 200, 300, 500 and numerous higher wattage. There are also some tube shaped ones.

Rough-service bulbs: Vibration-service and rough-service bulbs are available usually in 50 and 100 watt size but also in 25, 60, 75, 150, 200, 300 and 500 watt sizes. Some come with special milk-white finish, but most come with inside-frosted finish. Larger sizes are often clear glass bulbs.

Lumiline tube: A lumiline lamp is a tube-type incandescent light bulb with an extended filament running the length of the long narrow tube. Fluorescent tubes are rapidly replacing lumiline tubes. The lumiline tube fits into a special fixture with cap-like sockets at each end. Lumiline tubes T-8 come in white or colors and in 30 (18"), 40 (12") and 60 (18") watt sizes.

Other special lamps: Some other special lamps on the market are:

Glow lamps (not incandescents) have electrodes instead of filaments to cause gas in bulb to glow. They are used for low wattage (1-3 w) night lights. Some of 1/25 to 3 w size have special bases.

Medium and candelabra screw base 110-125 ac or dc. Decorative lights, 6, 7½, 10, 15 and 25 w.

Indicator or night lights of various types and small sizes.

Christmas tree lights for indoor and outdoor use.

Radio dial lights.

Other special purpose bulbs for use in electrical equipment.

Points to Consider in Selecting Incandescent Light Bulbs

Standards and specifications: While light bulbs may all look alike, there is sometimes a difference in quality. It is advisable to buy from reputable manufacturers who conform to the Federal specifications and standards set up by the American Standards Association for incandescent bulbs.

Voltage of lamps: Ordinary bulbs are made for 110, 115, 120, 125 and 130 volt circuits. REA borrowers generally design electric distribution systems for 120 volt service. Therefore, you should look on the end of the bulb for the stamp, "120 V," unless a different voltage is suggested by your power supplier.

On 120-volt service, a 110 or 115 volt bulb will burn more brightly but will not last so long as a 120-volt bulb. Using a 125 or 130-volt light bulb on 120 volts will give less light and longer life.

Wattage of light bulb: Manufacturers indicate wattage, marking it in the same place as the voltage on the end of the bulb. Study the sizes generally suggested for certain uses and also consider that larger bulbs give more light in relation to the electricity consumed than smaller ones. If you have four 25 watt bulbs, they will give less light than a single 100 watt bulb. It takes six to give about the same amount of light. Most smaller bulbs are vacuum bulbs; larger ones, 40 watts or larger, are gas-filled and more efficient than vacuum bulbs. Efficiency increases with higher wattages.

Sizes of screw base: The bases that are available in light bulbs designed for home use vary in size. Mogul base bulbs are used in many floor lamps and a few table lamps. Standard or medium bases are used in most places. Intermediate or candelabra screw bases are for decorative lights, and miniature screw bases are for Christmas tree lights. It is best to get seeing equipment which takes either Mogul or medium base bulbs for easy bulb replacement. Converters to make various bases usable in different sockets are available.

Shape and size of bulbs: Different letters are used to designate the different shapes of bulbs. "A" is used for the regular shaped bulb, "G" for large three-light or small decorative globular or round ones. "P" for pear-shaped ones, "F" for flame-shaped ones, "T" for tubular ones and "S" for straight-sided ones. Neither the small globular or flame shaped bulbs are used so much anymore. The ordinary A-shaped bulbs have grown smaller in size as their efficiency has increased. Bulbs are classed by the diameter measurement in eighths of an inch.

Color and type of glass in bulbs: Colored bulbs are sometimes used for decorative purposes, but usually inside-frosted light bulbs are used because of their greater efficiency. Clear glass bulbs are also available, but they produce more glare and little more light than inside-frosted light bulbs. The silica or ceramic white inside coatings or enameled finishes of white bulbs improve diffusion, but give a little less light than inside frosting. Pyrex glass is used in PAR bulbs and more expensive infra-red bulbs to protect them for use in places where water may hit the hot bulb.

Grade of bulb: Sometimes different grades of bulbs can be purchased. The best is usually only 5¢ more than the poorest.

1. American made light bulbs: American made light bulbs bear the wattage, the voltage and the name of the manufacturer. Good quality light bulbs do not blacken prematurely, are efficient and last a long while, from 750 to 1,000 hours. Lumiline (1,500) and a few small lamps last 1,200 to 2,000 hours.

2. Nameless make bulbs: From time to time a few poorly labelled bulbs come on the market; these are mostly imports. They usually last 400-600 hours but may burn out at any time and frequently break at the base when screwed into the socket.

Use and Care of Incandescent Light Bulbs

Care of incandescent bulbs: Bulbs require little attention and care. Here, however, are a few points to keep in mind:

1. Vibration: Avoid jarring, dropping and severe vibration of light bulbs. A jar will often break an old or defective filament. Rough-service or vibration-service light bulbs are available for places where there is a lot of vibration.

2. Control: Control light bulbs with a switch. Do not screw light bulbs in and out as a means of controlling light. This causes arcing in the socket and eventual damage to it. Various types of sturdy switches are the best method of control. Some three-light bulbs have a switch built-in at the base. A pull chain is a less desirable switch control, for it is often a source of trouble and even sometimes a safety hazard. A pull chain becomes dangerous when the insulating link in the chain is lost.

3. Burning position: Use light bulb in position for which designed. Some bulbs are designed to be burned in special positions as base up, or base down. These recommendations should be followed.

4. Moisture: Avoid using ordinary light bulbs in places where moisture can spatter on them when hot. Light bulbs with special glass are available for many of these locations, In some places, shielding helps. Special moisture-proof fixtures are available for shower stalls and similar spots.

5. Cleaning: Dust or wipe bulbs with a damp cloth; never immerse in water. Remove light bulb from socket to clean. Use a damp soapy cloth on greasy bulbs. Dry carefully. Some manufacturers say immersion is possible with thorough drying afterward.

6. Blackening: Change light bulbs when old and blackened. Move badly blackened bulbs to less important places until they burn out. Blackening may waste quite a bit of light. Blackening on the top of a bulb in a study lamp, however, is not so serious as it may seem because it cuts the light going upward rather than that going downward. Some places where blackened light bulbs of larger size will serve a useful purpose until they burn out are in closets, unused parts of attics and basements, halls, and in parts of farm buildings.

7. Supply: Keep an extra supply of varying size bulbs to provide replacements of the proper size when a bulb burns out.

Cost of operating bulbs: Below are formulae in figuring power cost for incandescent light bulbs:

Watts x hours of use = number of watt-hours

$$\frac{\text{No. of watt-hours}}{1000} = \text{Kilowatt-hours}$$

Kilowatt-hours x ___¢ per kwh = ___¢ (cost of lighting)

Power suppliers sell electricity by the kilowatt-hour. A kilowatt-hour is a thousand watt-hours. Kilo is the Greek for thousand. A 100 watt bulb will give light for ten hours to use one kilowatt-hour. It is interesting to compare the cost of lighting with automobile operation, alcohol, cigarettes, movies, candy or gum. There is probably no cheaper way of entertaining your family so wholesomely as by spending your money on lighting. Good lighting makes it possible for them to read and play safely and comfortably at home.

Types of Fluorescent Tubes

New development: The fluorescent tube for home use is a comparatively new lighting development; it came into use in 1938. Instead of one or two filaments centered on the inside, it has two concealed filament-like electrodes, each connected to two pins. You find these at opposite ends of the tubes, but since they are inside of the tube, you see them only in a broken tube or in a clear-glass germicidal lamp. The pins serve as the tube's bases for connection to lamp holders and in turn to wiring. Between these electrodes and inside the tube is a drop of mercury for mercury vapor, which in operation becomes a part of the circuit. Argon, one of the gases used in ordinary gas-filled bulbs, and sometimes krypton or neon are also used in various combinations. Krypton makes for greater efficiency but both neon and argon have advantages in operating at lower or colder temperatures; argon helps lamps start easily. Mercury vapor lamps are not new (Cooper Hewitt--1900), but previously they gave little light. Adding a light-converting coating or phosphor to the inside of the glass enclosure causes ultra-violet rays to change wave length and become light.

Fluorescent tubes have wide acceptance for home use now. You will find them in special bathroom, kitchen, workroom or laundry and under-cabinet lighting fixtures. Also, the new warmer fluorescent colors are increasing the popularity of fluorescent lighting for the living areas of the house. Fluorescent fixtures are fairly expensive because of the auxiliary equipment or special control units built into them to control the voltage. Also, volume demand is just beginning to lower production costs.

Special floor, table and wall lamps use circular, semi-circular or straight fluorescent tubes. You can find either portable or stationary equipment for any use, for the fluorescent fixtures and lamps now come in both decorative and utilitarian designs.

Parts of fluorescent lighting equipment: Below are listed the main parts of commonly used fluorescent lighting equipment:

Tube
  Glass tube; phosphor coating inside
  2 2-pin bases on straight tube or
  1 4-pin base on circular tube
  2 electrodes inside tube
  Mercury, argon, krypton, neon in tube
2 lamp holders for 2-pin bases on tube ends
or 1 4-hole holder for 4-pin base on circular tube
Auxiliary equipment for ordinary tubes:
  Current limiting device or ballast
  Starter switch and radio interference condenser

Ordinary fluorescent lighting tubes require certain auxiliaries. This auxiliary equipment includes a current-limiting device called a "ballast" and a starter switch. These usually go in the body of the fixture itself, in a part called the channel. In a portable lamp, however, the ballast, because it is heavy, goes in the lamp base and helps weight it.

Ballasts vary in size, shape (square, rectangular and round) and weight according to the size and number of tubes used and the location of use. Some are instant-start ballasts for use with instant-start tubes. There are also starters which stop the operation of a tube when it starts to flicker. A good fixture has a capacitor or condenser to lessen radio interference. In some new fixtures it is built into the starter.

The coating on the inside of the tubes is a powder which is fluorescent. It glows and gives off light when ultra-violet rays reach it.

The ordinary mercury vapor lamp gives off short invisible ultra-violet rays and a light of a peculiar blue-purple color. The fluorescent powders, or phosphors, change the invisible ultra-violet rays to visible light and produce a great deal of light for the amount of electricity used. Various combinations of phosphors give different colors of light.

Sizes and types of fluorescent tubes:

Pre-Heat Hot-Cathode Fluorescent Tubes

Wattage	Length	Diameter in 1/8"	
4 w	6"	T-5	5/8
6	9	T-5	5/8
8	12	T-5	5/8
13	21	T-5	5/8
14	15	T-12	12/8
15	18	T-8	8/8
15	18	T-12	12/8
20	24	T-12	12/8
25	33*	T-8	8/8
30	36	T-12	12/8
40*	48	T-12	12/8
100	60	T-17	17/8
Instant-Start Tubes (No Starters)			
40	48	T-12	12/8
40	48	T-17	17/8
40	60	T-17	17/8**
85***	58	T-10	10/8
90*	60	T-17	17/8
Sizes of Fluorescent Circular Tubes			
32 circle	12" D	T-10	10/8
18 semi "	12" D	T-8	3/8

Slimeline Long-tube Hot Cathode Type

Wattage	Length	Diameter
100-300 milliamperes		
16-33	42"	T-6
24-51	64"	T-6
22-51	72"	T-8
29-69	96"	T-8
400-600 milliamperes		
36-52	48"	T-12
54-72	72"	T-12
72-96	96"	T-12

Slimline lamps may be operated at various currents to produce different amounts of light -- more at higher currents (given in milliamperes, ma)

Cold-Cathode Series-Burning

52"	20 mm	84"	20 mm
64"	20	93"	20
76"	20	93"	25

Fluorescent light-source shapes and colors: There is a wide variety of shapes, sizes and colors of fluorescent tubes from which to choose.

Shape of tube	Old fluorescent color terms		New fluorescent color terms
Straight tubes	White--3500° K.	Gold	Standard cool white--4500°
Circular	White--4500°	Red	Deluxe cool white
Semi-circular	Daylight--6500°	Pink	Standard warm white--3000°
U-shaped	Soft white	Green	Deluxe warm white
Bulb-like	Warm white--3000°	Blue	Gold, red, pink, green, blue

If you haven't been completely happy with the lighting effect achieved with fluorescent lamps, it may be because you haven't seen some of the newer tubes which the lighting engineers have developed. These are called Deluxe Cool White and Deluxe Warm White. The light from these tubes is more flattering to complexions and also brings out red coloring in interiors more vividly.

The lighted appearance of these tubes closely matches the Standard Cool White and the Standard Warm White, but the deluxe ones give far better color rendition. However, the new tubes are of lower efficiency, although they are still better in this respect than the incandescent bulbs.

Analysis shows that people are conditioned to two basic types of atmosphere. In the work world--factories, offices, schoolrooms and in most stores a

*25" krypton-neon cold weather tube and 90" krypton-argon, 40" common size low temperature tube.
**Replacement lamp only, to fill existing equipment. New equipment not being made.
***Also available in single-pin base.

cool, neutral atmosphere is usually desired. Here, high efficiency of light becomes the first consideration. In the home, and in other social environments, a warmer atmosphere is preferred, and here excellent color rendition is usually paramount. (The latter also applies to certain areas in the work world, of course--a room devoted to art classes, a millinery plant, a meat market, a specialty or florist shop, for example.)

This development in fluorescent lamps seems likely to assure much greater satisfaction in their use, especially where color is an important element. If you are planning to use these new colors you should know their characteristics:

Standard Cool White (4500° White)
Like natural daylight; blends with it
Suitable for areas--kitchen, laundry
Factories, stores, schools, offices
Lower efficiency than Standard Warm White
10 to 15% more efficient than daylight (6500°)
Initial cost lower than deluxe tube

Deluxe Cool White
Has balanced color spectrum
Gives best over-all color rendition
Accents blues, grays, greens, whites
Does not sacrifice reds, oranges, wines
Gives 20% less light than standard cool
Has lower brightness than standard cool
Suits color inspection home work areas:
  washing, ironing, sewing, make-up centers
Costs more initially than Standard Cool White
Matches Standard Cool White when lighted

Standard Warm White (3000°--warm white)
Called warm white, warm tint or warmtone in past
Contributes to warm social atmosphere
Resembles incandescent light; used with it
Has highest efficiency of any fluorescent
Emits little blue light
Costs initially same as Standard Cool White
Emphasizes yellows, oranges, greens
Tends to make complexion appear sallow

Deluxe Warm White
Creates warm stimulating atmosphere
Has balanced color spectrum
Suits social environments
Adds gold tint to skins, whites
Gives 20% less light than Standard Warm White
Has lower brightness than Standard Warm White
Accents warm colors, reds, oranges, yellows
Matches Standard Warm White when lighted

Soft White (pinkish white)
Improves appearance of skins, meats
Produces tinted atmosphere--bluish pink

The four lamps--Deluxe Cool White, Deluxe Warm White, Standard Cool White and Standard Warm White--give light appropriate to interiors of practically all classes, from factory to home. The following chart indicates the right lamp to use for different purposes.

For	Use
Best over-all color appearance	Deluxe Cool White
Highest efficiency light (most light per dollar)	Standard Warm White (formerly "warm white")
Cool atmosphere--efficient light	Standard Cool White (formerly 4500° white)
Warm atmosphere--efficient light	Standard Warm White
Good over-all color appearance--warm atmosphere	Deluxe Warm White
Best over-all color appearance--cool atmosphere	Deluxe Cool White
Combination of fluorescent and incandescent light in same area	Standard Cool White for contrast: Standard Warm White for blending
For blending with natural daylight	Deluxe Cool White

Manufacturers will undoubtedly develop other fluorescent colors.

Points to Consider in Selecting Fluorescent Tubes

Sizes: In this type of light source, the wattage varies with the length of the tube. The sizes most commonly used in the home are the 14-watt, 15-inch; 15-watt, 18-inch; 20-watt, 24-inch; 25-watt, 33-inch; and 40-watt, 48-inch. The 30-watt, 36-inch tube is used more commercially.

Shape: The long narrow tubes fit well into new streamlined fixtures of rectangular shape, coves or cornices and valance lighting.

Circular and semi-circular tubes fit in round fixtures and under the round shades of floor and table lamps. Also they make good round shaving mirror lights. The 12" diameter 32-watt circline tube is commonly used, and a few 8" ones appeared in 1950. A third, 16" size will complete a group to nest conveniently in ceiling fixtures--total 95 watts not including ballast wattage.

Colors: Color names for white fluorescent tubes are undergoing a change, introducing four new terms: Standard Cool White and Deluxe Cool White, and Standard Warm White and Deluxe Warm White. However, fluorescent tubes are still being made and sold by earlier names. These are 3500° and 4500° white, 6500° daylight, warm white and soft white, also in gold, red, pink, green and blue. The 3500°* white tube is in common use now in the home. The 4500° white and soft white are fairly widely available; 6500° daylight

*3500 degrees Kelvin--3500 K.

is less in favor. The newer white tubes give a warm light glow resembling incandescent. The deluxe ones, especially deluxe warm white, fit well in the living areas of the home. Deluxe Cool White should be good for use at make-up mirrors, in laundries and sewing rooms--or in work areas of the home where color discrimination is involved. Deluxe Cool or Warm White types give about 20% less light but better color rendition than standard types.

Light distribution: Fluorescent tubes are "lower in brightness" than incandescent bulbs of the same wattage, making them less glaring when viewed either directly or when reflected from shiny surfaces such as polished desks or tables. Shielding is desirable, but it can be thinner than incandescent shielding. This wastes less light.

The light is distributed over a long tube, thus providing more even illumination than a point source of light. The lighted tube is brighter in the center than on the ends, but this is not readily apparent.

Efficiency: Fluorescent tubes are more efficient than incandescent light bulbs in light output. They give two to three times as much and often more light (up to 200 times as much in green)depending on the color, for the same wattage or power. Lower wattage lamps can be used in the same place if it is fluorescent light. However, in using the bluer white fluorescent light the effect is sometimes cold and depressing with a small amount of light, while this effect is not so noticeable with a larger amount of fluorescent light.

Life: The most commonly used fluorescent tubes are rated at a life of 2500 to 4000 hours. Many of them now last 7500 hours at three hours per burning start. Instant-start tubes do not last as long as ordinary ones, however. Some recent life reports on newer equipment show figures above 10,000 burning hours.

Coolness: Fluorescent tubes give off only a fraction of the heat given off by an ordinary bulb. They are barely warm to the touch. Some sources state that there is 50 percent less radiant heat than from a standard incandescent bulb, and that what heat there is, is spread over a wider area. However, there is some heat from the ballast. In installing built-in equipment, ballasts can go in a place separate from tubes.

Cost of tubes: The cost ranges from 75¢ for the 4-watt tube to $2.50 for the 100-watt tube. Instant-start tubes cost from $1.00 to $3.25.

Advantages, disadvantages: Below is a brief listing of advantages and disadvantages of fluorescent lighting and equipment:

Advantages of Fluorescent	Disadvantages of Fluorescent
Efficiency 3 times incandescent	High initial cost for equipment
Color discrimination excellent	Equipment heavy, often bulky
Light whiter, nearer daylight	Fixture tube wattage and length
$\frac{1}{4}$-$\frac{1}{2}$ as hot as incandescent	not changeable after installed
Lower brightness--needs less shielding	Radio interference in some cases
Shadows softer, reflections less bright	Slow start, flicker in some cases
Tubes last 3 times as long	Unsuitable below 35°*, over 120° F

* Special tube in 40 watt size available for low-temperature use.

Advantages of Fluorescent	Disadvantages of Fluorescent
Better distribution, larger source	Uncertain starting at excessive undervoltage and low temperature
Variety in fixture shapes, sizes	Frequent startings cut tube life
Operates on 110 to 125 volts with only about 5% change in light output	High upkeep cost: tubes, repair

Use and care of fluorescent tubes: In using fluorescent equipment:

1. Avoid turning it on and off frequently. This wears the electrodes out more rapidly.

2. Avoid using when flickering, as this may damage the ballast and the starter by over-heating them. A special type of starter will stop the tube from operating when it starts flickering. It costs little more.

3. Locate radio about 10 feet (6'-9' may be enough) away from fluorescent equipment and/or use radio interference device.

Cost of operating fluorescent tubes: Below is a cost formula:

$$\frac{\text{watts} \times \text{hours of use}}{1000} \times \_\_\_\ \text{¢ per kwh} = \text{cost}$$

Add ballast wattage to tube wattage for correct total wattage.

Health Lamps

In the electromagnetic spectrum long waves known as infra-red rays are at one end of the light spectrum, and short waves known as ultra-violet are at the other end. Both of these have health applications.

Heat lamps (incandescent): Some reflector-shaped and A or G bulbs make use of these long-wave, infra-red or heat rays to relieve congestion and pain in humans and animals. The radiant energy from the lamps penetrates flesh deeply. Infra-red lamps (usually 250 w, also 80-375 w and three-light 50-200-250, vary quite a little in price, the difference being chiefly due to the glass used. The more expensive bulb available in 250 w size is a special glass bulb which withstands breakage when cold water splashes on the hot surface of the lamp. A red, amber or blue glass on some helps lower the brightness of the bulb. In 80, 125, 200, 250, 375, 400 and 500 watt sizes, these bulbs are used industrially for drying purposes.

Sun lamps (R-S--electric discharge--and fluorescent: Ultra-violet rays similar to those found in natural sunlight can be produced by several artificial light sources. Among these are carbon arcs electric discharge lamps and special fluorescent type lamps.

The R-S sun lamp is an electric discharge type lamp which radiates beneficial ultra-violet energy. This lamp requires no auxiliary equipment or reflector because the entire unit is self-contained. The R-S sun lamp consumes 275 watts. It is 5" in diameter. The bulb is made of special glass which permits only sun-tanning ultra-violet, visible light and heat to pass and the glass can withstand sudden temperature changes without

cracking. Therefore, this lamp may be used in locations where it may be splashed by water.

Inside the outer reflector bulb is a smaller arc tube which contains a small portion of liquid mercury and argon gas. When the lamp is lighted, the mercury is heated to vapor and ultra-violet rays are generated.

The R-S sun lamp can be used in any standard 110-125 volt, 50-60 cycle, a-c household socket. Many special type fixtures are available, but ordinary adjustable brackets or old bridge style lamps are satisfactory. The R-S sun lamp provides light for reading, sewing or playing, as well as the ultra-violet and a small amount of heat. Many families install this lamp over the mirror in the bathroom, so a suntan may be acquired by the men shaving or the women fixing their hair. When mounting the lamp over the mirror, it should be placed 18"-24" above the forehead and directed so the lamp shines downward.

The newest sun lamp available is like a fluorescent tube. It comes in 20 and 40 watt sizes. Other ultra-violet lamps such as the 400 watt Mogul base S-1 and the 100 watt admedium S-4 are available but require special equipment and transformers for proper operation.

Users should carefully follow instructions given with sun lamps, or a painful sunburn may result due to carelessness or untimed exposure. Special glasses are sometimes used to protect the eyes during an ultra-violet exposure.

Fluorescent sun lamps: Tube sun lamps look like fluorescent lamps and produce light in the same manner. The difference between them is that the sun lamp has a special phosphor and glass which transmit wavelengths over 2800 Angstroms up to the bluish visible light at about 3800 A. Ordinary fluorescent lamps transmit visible light in wave lengths above 3800. These sun lamps are available in 20 and 40 watt sizes as mentioned earlier. The length of the tube permits a large area of the body to get uniform treatment in one exposure. When used for personal irradiation. The lamps also find use in installations for room irradiation. Lamps work satisfactorily in ordinary fluorescent fixtures but require special reflectors usually of aluminum. The sun lamps find use for animals and poultry as well as humans--it is wise to follow instructions for use carefully.

Germicidal lamps: Germicidal or bactericidal radiation comes from a lamp operating like an ordinary fluorescent tube. It has a special glass to transmit ultra-violet rays. This glass lacks light-converting phosphor and appears as a clear glass tube. There are a number of types--hot and cold cathode and slimline--in various lengths and wattages. They produce short-wave ultra-violet around 2500 A. which kills micro-organisms which the rays strike directly. The rays will not penetrate most substances; an exception is clear water. Some of the lamps produce ozone.

Since exposure to the rays transmitted may redden skin and irritate eyes, damage plant life and fade some dyes follow instructions for use carefully.

Germicidal lamps find use in protection of humans and animals and of products such as food and pharmaceuticals.

Summary

Point, line and area electric light sources have been invented to provide man with another form of artificial lighting. In addition, there are health lamps available to give him infra-red and ultra-violet radiation for health and production. These require careful use.

Incandescent bulbs: Common incandescent bulbs, because of the small filament, provide light from a point source. This produces problems of eye comfort, requiring great care in diffusion and shielding. However, with proper control, ordinary incandescent light bulbs in larger sizes used in commonly available equipment can furnish good lighting. For local close seeing tasks and also for general home lighting, chiefly from central ceiling fixtures, 40 to 450 watts total is the common range of wattage used, the amount depending on the task or area to be lighted. Bulbs usually require some shielding for eye comfort. White indirect-light bulbs and even the smaller white bulbs furnish a larger light source than inside-frosted bulbs. The white indirect-light bulbs require no diffusing bowl when used in lamps. This bulb in a lamp is satisfactory for nearly all work in living areas except prolonged close eye work, such as studying, for which the source brightness, especially for shiny papers, is too high. However, it is a satisfactory light for hand sewing on dull materials, provided it is used in a well designed lamp and is well placed. Three-light bulbs give three amounts of light from the same bulb and thus furnish light for different types of tasks. Blue bulbs give a light like daylight -- excellent for color matching, but not commonly used.

Fluorescent tubes: Fluorescent tubes are a line source of light. They are less expensive to operate, more efficient (about three times), and last at least three times as long as ordinary incandescent bulbs. Many fixtures and floor lamps use fluorescent tubes as sources of light, but the fixtures still cost quite a little to buy, because of the auxiliary equipment and extra wiring in them. Because fluorescent tubes are a line source of relatively low brightness, use of some of the less dense diffusing materials for shielding is possible.

Area sources: Electro-luminescent lighting equipment is an area source of light still in the developmental stage. Line sources, or tubes, provide an area source of light when mounted above certain diffusing materials as in luminous ceilings. Corrugated plastic or paper sheets are used.

Operation: Ask what voltage your lines deliver and buy light bulbs or tubes for that voltage. Keep an extra supply of light bulbs and tubes on hand so that you will have the right size ready to replace a burned-out light source. Keep equipment clean. To figure roughly what it costs to operate lighting equipment use this:

$$\frac{\text{Watts} \times \text{hours of use}}{1{,}000} \times \underline{\quad\quad}\,¢ \text{ per kwh} = \underline{\quad\quad}\,¢ \text{ cost.}$$

WIRING FOR GOOD LIGHTING

Code Allowances

The National Electrical Code makes the following wiring allowance suggestions for industrial and public buildings in watts per square foot.

Type of Occupancy	Watts per Sq. Ft.
Auditorium, churches, armories	1
Clubs, hospitals, hotels, industrial lofts, offices	2
Barber shops, schools, stores, dwellings	3

A similar watt-per-square-foot guide, given below may be used to serve as a rough lighting calculation guide:

W per Sq. Ft.	Approx. Ft-c.	Condition of Ft-c. Delivery	Space for Which Suitable
1	5		Corridors, storage space
2	10-15	Industrial area	Rough work, packing, crating
	8-12	Commercial area	Casual, intermittent attention
4	15-20	Indirect	General industrial areas, stores,
	30	General diffuse	schools, offices
6	30	General diffuse	General offices, stores
7	30	Indirect	Small interior--offices, classrooms
8	30-35	Indirect	Small private offices (20x20')
12-15	20-30	Architectural	Unusual treatment and lighting effects

Home Lighting

Several general suggestions on wiring for home lighting are given in the section on planning lighting. Below are a few points on location of lighting outlets, switches and convenience outlets.

Provide enough lighting outlets: A few points on locating lighting outlets in the home are given below:

> Ceiling light in each room (except possibly bathroom less than 40 to 50 sq. ft. with mirror brackets), or lamps on switch-controlled outlets. Two ceiling fixtures in rooms twice as long as wide, over 400 sq. ft., with alcoves or with very low ceiling, one preferably an architectural or applied fixture. Light at mixing center, sink, range, mirrors. Light at sorting, washing and ironing centers. Light on porch, each 15 ft. of hall and closets over 9 sq. ft. or 18" deep. Light at head and foot of stairways.

Plan good location of switches, lights: It should be easy to control light and get it where you want it. Below are a few points on planning location of switches and outlets.

> Switches--42"-48" above floor, on lock side of door, near doorway. Lights--usually centered in ceiling; may be centered over work, dining or mirror area. Wall brackets--usually 5' 6" or 8" above

floor and paired (5' 1" or 2" and 30" apart in bathroom). Halls--light for about each 15' of length controlled at main entries, near stairs.

Plan good location of outlets: Convenience outlets properly placed permit good placement of lighting equipment.

Living areas--cords 6' long; outlets for each 12' of wall space or for any usable space over 3'. Dining area--no space more than 10' from outlet; 20'--1 outlet. Work areas--convenience outlet on appliance or 20 ampere circuit, and lighting outlet at each work center, 40-42" above floor.

RECOMMENDATIONS, SPECIFICATIONS AND CERTIFICATIONS

The Illuminating Engineering Society (IES) is a recognized lighting authority and has published bulletins on recommended lighting practices, which are condensed in IES Lighting Handbook, 1951, Illuminating Engineering Society, 51 Madison Avenue, New York City.

Associations of manufacturers (number participating given in parentheses) having equipment certification and testing contracts with Electrical Testing Laboratories, Inc. (ETL), New York, New York are:

CLM--Certified Lamp Makers (45), portable lamps; 105 specifications.
AHLI--American Home Lighting Institute (25) for residence fixtures. This program has been suspended.
RLM*--RLM Standards Institute (13) for RLM industrial fixtures.
Fleur-O-Lier Manufacturers (27) industrial, office, school fixtures.
Certified ballast manufacturers (7) for fluorescent ballasts**.
Certified starter manufacturers (10) for fluorescent starters**.

CLM lamp specifications cover lighting performance, mechanical construction, electrical construction, safety. For each model of portable lamp there is a statement of the lighting service for which the lamp is intended, the illumination to be delivered on a prescribed test plane and the proportion of this illumination that must come from the ceiling and upper side walls as well as from the outside of the shade. Before a certified tag can be placed on a lamp, a model must have been tested and approved by Electrical Testing Laboratories (ETL) for compliance with 105 CLM specifications.

AHLI specifications for fixtures were planned to cover safety, construction requirements and lighting performance, including footcandle values, distribution, efficiency and comfort requirements related to shielding and brightness. Fixtures meeting specifications were to carry a UL label, an AHLI label. And they were to be marked with lamp size or sizes to be used, hanging height or range of hanging heights, room size for which intended (marked if for 60 square feet or less), and whether intended for studying, reading or writing. The AHLI program has been suspended; write for information before discussing.

Reference addresses:

CLM, 2116 Keith Building, Cleveland 15, Ohio.
AHLI, 5905-6103 Longfellow Avenue, Cleveland 3, Ohio. (Program suspended)
RLM, 307 North Michigan Avenue, Chicago 1, Illinois.
Fleur-O-Lier Manufacturers, ETL, 2 East End Avenue, New York 21, New York; also 2116 Keith Building, Cleveland 15, Ohio.
ETL, Electrical Testing Laboratories, 2 East End Avenue at 79th Street, New York 21, New York.

*RLM stands for reflector and lamp manufacturers.
**Comply with "Specifications for Fluorescent Lamp Auxiliaries."